THE MODEL ENGINEER

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THE MODEL ENGINEER

EVERY THURSDAY

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Our Cover Picture

Model power boat activities have been greater than ever this year, and regattas, very well attended by competitors and spectators, have taken place nearly every week-end at various places throughout Great Britain. This photograph was taken at the Blackheath regatta, one of the last in the season, and illustrates a typical scene in the "pits," with competitors in the "C" class (10 c.c.) fuelling up and preparing their boats for the race. Now that the competition season has closed, the exponents of both racing and prototype classes of boats are busy in their workshops, repairing or improving their craft, building and testing new engines, etc. in preparation for renewed regatta activities next spring. Speed boat enthusiasts will, however, have an opportunity to add further to their achievements any time up to the end of the year, as runs made any time up to this date are eligible for entry in the Annual "M.E." Speed Boat Competition, particulars of which, including revised rules, will shortly be published.

SMOKE RINGS

A Risky Prophecy ?

IN OUR issue for October 15th, 1903, we published the following paragraph: "Sir Frederick Bramwell has offered £50 to be invested by the British Association, the accummulated sum to be awarded fifty years hence for the best essay on the then condition of the steam engine. Last year Sir Frederick declared his belief that in half-a-century steam engines will be extinct, and this offer is the backing of his prophecy. At 3 per cent. the £50 will have increased to about £225 in 1953, and is then to be awarded for the best funeral eulogy of the obsolete steam engine."

There is scarcely any need for us to remark that the prophecy contained in that paragraph has failed to come about; at least, steam engines are anything but extinct fifty years after the prophecy was made. That anyone could have had so little faith in the steam engine in 1903 seems to us to be remarkable. About five years before, intensive investigations into the generation and application of superheated steam had begun, in Germany, and five years later—that is, 1908—the problems arising out of the use of superheated steam had been all but overcome. This revolutionised the steam engine and gave impetus to improvements in design resulting in far better and more economical performance. In this month of October, 1953, the steam engine is still holding its own as one of the prime sources of power; its form, however, is admittedly different from that known to Sir Frederick Bramwell, who, after all, was a well-known civil engineer in his day and, therefore, his opinion of the steam engine may have been somewhat distorted. But was it ?

To satisfy our curiosity, we got in touch with the British Association and learned that the paragraph we have quoted above arose out of some remarks made by Sir Frederick in 1881, in which he inferred that, fifty years hence, the number of steam engines being made would be small compared with that of internal combustion engines. A paper read to the Association in 1931, by Professor Ewing, showed how true was the prophecy. Although Sir Frederick made his offer in 1903, he stipulated that the award should be made in 1931, and this instruction was duly observed and acted upon.

Centenary of the "A.B.C."

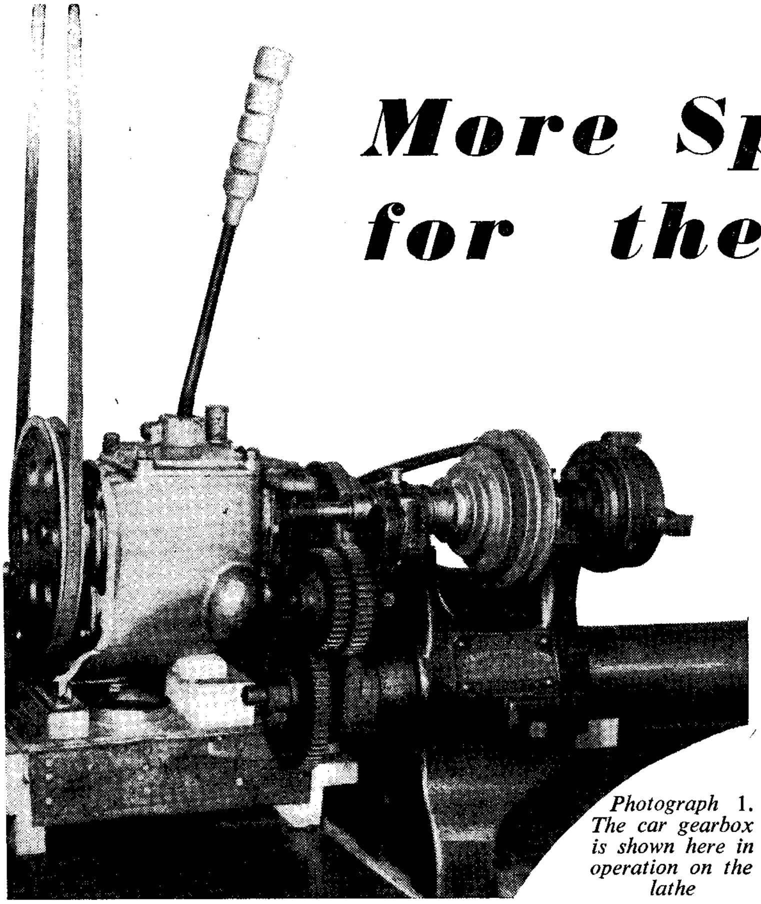
THIS MONTH of October, 1953, marks the centenary of the A.B.C. Railway Guide, and we feel that the occasion should not pass without a small tribute. We are regular subscribers to this traveller's *vade-mecum*, and our copy is not only always within reach, but is very frequently consulted each month. When the "A.B.C." was first published in October, 1853, London had about one quarter of its present population and only 37 railway stations; the number of stations in Britain was, proportionately, far less than this, but we know that 100 years later, there are 6,026 railway stations and all of them are mentioned in the "A.B.C." In short, this popular guide has kept pace with railway developments, and has added an enormous amount of information regarding air services, railway steamship services, hotel accommodation and the like, thereby making itself an indispensable companion to all who have need of such information. We salute it, and offer it our best wishes for the future.

Ardeer Recreation Club

FROM NOBEL's Ardeer Factory, Stevenston, Ayr, we have received a letter from Mr. J. Templeton, hon. secretary of the Model Engineering Section, who tells us that since last November the club has been busy erecting a continuous multi-gauge miniature railway in the firm's recreation ground. The circuit is approximately 450 ft. and is laid to 5-in., 3½-in., 2½-in. and 1¼-in. gauges. The locomotive section remains the most popular and all the locomotive builders are ardent "L.B.S.C." fans.

More Speeds for the Lathe

By J. K. Waggot



Photograph 1. The car gearbox is shown here in operation on the lathe

I DO not imagine for one moment that the scheme of using a motor-car gearbox in place of a lathe countershaft is original, but as I have never seen it in print, I am submitting this description in the hope that others may have the same fun as I did in making up and using the fitment.

I had already made some experiments with motor-cycle gearboxes which are light in weight, very compact and have a conveniently sized clutch mechanism. However, they are mostly so designed that the drives from the engine and to the rear wheel are both on the same side of the box, and this, together with the use of chain sprockets, would make conversion to belt drive a very troublesome matter. The absence of an internal reverse gear is another disadvantage and, all in all, it seemed that to use a car gearbox with the drive "in at one end and out at the other" was much the more convenient and satisfactory method of achieving the required objective.

While the idea has advantages in connection with any lathe, except perhaps one with a built-in geared head, it is particularly suitable for a round-bed Drummond, which is not supplied with a back-gear. In any case, the cost of a geared-head lathe can be prohibitive. Also, if the opportunity is taken to change to vee-belting, two good fat birds can be felled with one brick—so to speak. With the system in use, a very good non-slip drive is obtained with an automatic safety device, to be mentioned later—and, with a $1\frac{3}{4}$ in. pulley on the motor shaft there is a range of 12 forward mandrel speeds of from 780 to 38 r.p.m., with 4 reverse speeds of from 180 to 29 r.p.m.

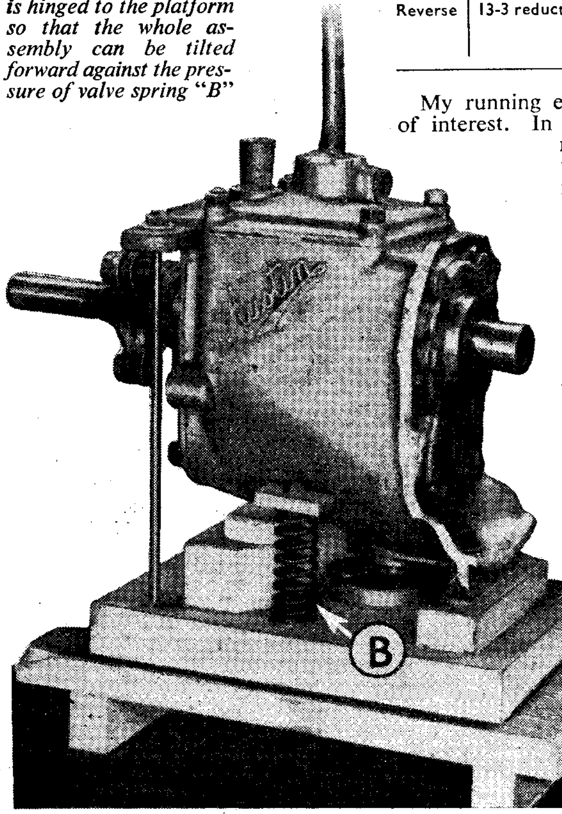
The main item, of course, is the gearbox, and here luck, opportunity, and bargaining ability all play their parts. I was able to obtain a 1932 Austin 7 three-speed box, complete with universal joint and prop. shaft, at a car breaker's yard for 25s., but the clutch mechanism had been removed. However, on dismantling, it was found to be in perfect condition—I had been lucky! First of all, the flywheel housing was hacksawed neatly away except for a piece at the bottom; some sweat was lost over this operation. The box was then thoroughly cleaned, inside and out, and reassembled; new brownpaper washers were made for all joints, and a felt oil-retaining washer for the primary shaft bearing. The fabric was removed from the universal, the prop. shaft cut to a convenient length, and the spiders cleaned and bolted together with their own $\frac{3}{8}$ in. bolts. Very tentatively, in top gear, the primary or input shaft was turned, and the output or countershaft carefully observed; it did *not* revolve like a dog's hind leg, but was as near true as "makes no matter." More luck—no fiddling with shims, etc. A flat was ground on the primary shaft, and the gear lever was straightened and cut to a suitable length. A base was then made from a suitable piece of wood, and wide slots were cut at each end, so that it could be fastened to the bench by means of coach bolts and bar washers, which gave a good measure of adjustment. The top was covered with a layer of felt to offset vibration. The next job was the gearbox platform, which was also made of wood; packing, appropriate to the contours of the underside of the gearbox, was used to level up, and the box was fixed to its platform at the countershaft end, by two long coachbolts, and a strap over the top, and, at the primary shaft end, by a bolt through a convenient hole in that part of the flywheel housing which was not removed. This simple method of fixing was found to be quite adequate. The platform was hinged to the base at the front by screwing on a piece of conveyor belting (A, Photograph 3). At the rear, a coachbolt fixed in the base passed through a slot in the platform; a valve spring (B, photograph 2) was placed over the bolt and secured by a washer and nut. Thus, the gearbox on its platform could be tilted forward against the pressure of the spring, and the spring tension could be adjusted by tightening or slackening the nut. This arrangement was required to facilitate changing the mandrel belt. The job appeared now as in Photograph 2.

The next items were the pulleys which, of course, could have been made. However, as I was now eager to see results, and had determined to change over to vee-belting. I "plunged" and bought four of those excellent "Picador" die-cast pulleys for ½-in. belts-1¾ in. by ½ in. bore for the motor shaft, 8in. by 1 in. bore for the primary shaft; also 2 four-step (5 in., 4 in., 3 in. and 2 in.) bored ⅞ in. for the countershaft and mandrel respectively. The 8 in. pulley was just too large to swing in the Drummond, and had to be bored out on a friend's lathe to fit the primary shaft, which was 1⅛ in. diameter; it was fixed on the shaft with its set-screw bearing on the flat. One of the four-step pulleys was bored out 1 in. to fit the mandrel, which was spot-drilled appropriately to take the set-screw; a suitable spacing collar was made, and the mandrel reassembled with its new fittings. The motor pulley and the other four-step pulley fitted their respective shafts without alteration. I would mention here that, before buying the pulleys, care was taken to see that there was sufficient material in the castings to enable the necessary boring out to be done. The gearbox arrangement now appeared as in Photograph 3, and the completed outfit as shown in Photograph 1. The box was half-filled with machine oil—to cut down drag—and, although there was a slight weep at the drain-plug, a tin lid, used as a drip-tray, took care of that; it is oil-tight otherwise. The placing of the motor is, of course, a matter of individual convenience.

With the pulleys mentioned, the following speeds are available at the mandrel :—

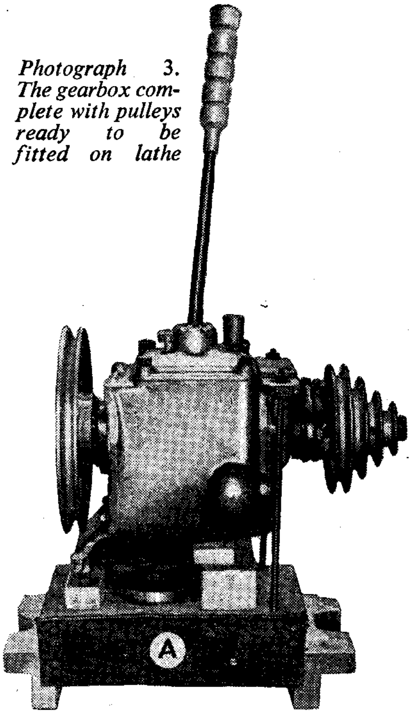
Motor-1,425 r.p.m. Primary shaft-312 r.p.m.

Gear	Primary/ C'shaft Ratio	C'shaft r.p.m.	Mandrel r.p.m.
Top	1-1 (direct gear)	312	780
			416
			234
			125
Second	11-6 reduction	170	425
			226
			127
			68
First	13-4 reduction	96	240
			128
			72
			38
Reverse	13-3 reduction	72	180
			96
			54
			29



Photograph 2. The gearbox mounted on its base and platform. The base is hinged to the platform so that the whole assembly can be tilted forward against the pressure of valve spring "B"

My running experiences may be of interest. In the first place, as mentioned above, there is an excellent non-slip drive at all speeds and, using a ¼ h.p. motor, there is any amount of power at the mandrel; little power seems to go to waste in the gearbox. There is no noise whatever in top-gear, which is a direct drive, but there is a slight hum in the indirect gears when under load. If the tool should dig in, the box jerks forward against the spring, the belt slackens and the mandrel stops—this is the "safety device" referred to previously.



Photograph 3. The gearbox complete with pulleys ready to be fitted on lathe

The vee belts need not be tight, and an outrigger bearing for the primary shaft is apparently unnecessary. The forward gears can be changed while the motor is running; thus, to stop the mandrel, simply shift the gear to neutral. This may not be good mechanical practice, but it works. My first job was to turn up a handle for the gear lever in hardwood, with hand-tools, and this was done most satisfactorily at the highest speed, giving a very good finish.

The following improvements are scheduled for the future: (1) A reverse switch for the motor, to give a mandrel speed range of down to 29 r.p.m., forward or reverse. (2) Double pulley arrangements on motor and primary shafts, to give higher mandrel speeds. (3) A clutch of sorts to improve the mechanics of operation. The original clutch would not have been suitable owing to the weight of the flywheel, but this could have been overcome, perhaps, by making a duplicate of the flywheel in wood. (4) An overhead drive, taken from a large single pulley on the end of the countershaft.

The photographs reproduced with this article were taken by A. B. Arthur, Morpeth, Northumberland.

BRITISH CRAMPTON LOCOMOTIVES

By E. W. TWINING

PART 6

IT has been said by many writers and critics that Crampton's *Liverpool* was a failure; this too as far back as the time when the engine was at work; but it was not the broad gauge partisans who cast aspersions upon her design and performances, for by that time the Battle of the Gauges was practically over; narrow gauge opposition interests were more contemptuous and condemnatory as were even certain sections of the North Western Company's own staff.

From the time of D. K. Clark, writing in his *Railway Machinery*, in 1855, down to the present day, authors have criticised the unusually long wheelbase of this engine, but every one of them appears to have overlooked the fact that the third pair of wheels, the pair next in front of the driving wheels, were without flanges and could, therefore, put no side thrust upon the rails. It must, however, be accepted as an undoubted fact that the engine did damage the permanent way—if the track could be looked upon as permanent. What could be expected of an engine weighing 35 tons, put to run upon light rails and sleepers which had been previously laid for, and called upon to carry nothing heavier than Edward Bury's small four-wheeled engines? It has been said, doubtless with truth, that some portions of the line consisted of early fish-bellied wrought-iron rails, in light chairs, spiked down to stone-block sleepers, with no fish-plates at rail joints, the rail ends being brought together in joint chairs.

Derailments

By way of further disparagement of the engine, the story was told that frequent derailment of other trains, following on the same line, took place after the passage of one hauled by *Liverpool*. Now *Liverpool*, on occasion, pulled trains consisting of up to forty, four-wheeled, carriages, doing the work for which at least three of Bury's little engines would have been required. Arising out of this the question may well be asked: if *Liverpool* could derail a following train, by spreading the gauge of the track, why did not, at least some, of the wheels of its own long train leave the metals?

The truth of the matter is that the engine was before its time: neither the permanent way nor the minds of the working staff, were ready for such a powerful locomotive and, although it worked traffic for about ten years its use was only merely tolerated and this fine engine was broken up in 1858. Had the Southern Division possessed, in 1848 to 1851, such a railway as that of the Great Western, between London and Bristol a very different story would have been told. Nevertheless, the engine was credited with having attained a speed of 79 miles an hour.

The interested reader may care to know the wheelbase measurements and axle loads, these were: Leading to second axle, 4 ft. 6 in.; second to third, 6 ft. 6 in.; third to driving axle, 7 ft. 6 in., total 18 ft. 6 in. Weights, on rail at leading wheels, 8 tons $10\frac{1}{2}$ cwt., second pair, 8 tons, $9\frac{1}{2}$ cwt., third pair, 6 tons and at the

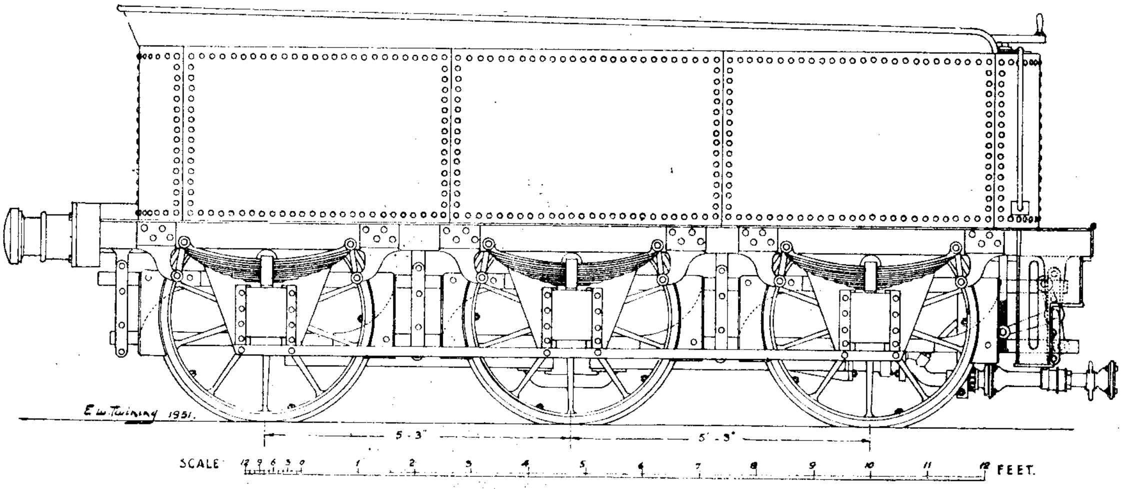


Fig. 13. Side elevation of the tender for the "Liverpool"

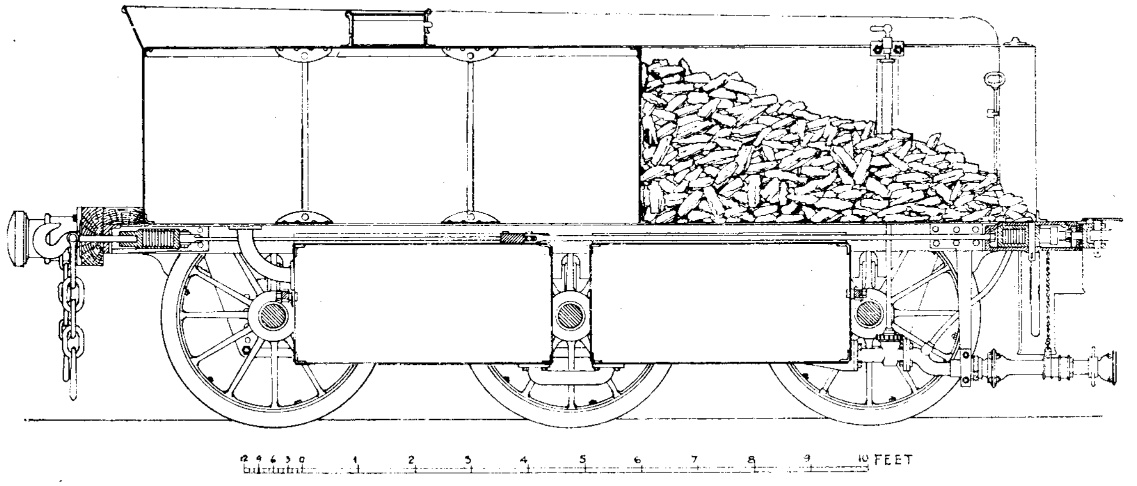


Fig. 14. *Longitudinal section*

driving wheels 12 tons. Total, in working order, as before stated, 35 tons.

The tender for the *Liverpool* is the subject of the three accompanying drawings, Figs. 13, 14 and 15. In Gooch's Great Western tenders, the brakes operated on one side only, there being six brake-blocks of hardwood, two to each wheel; all on the left-hand side, and applied on some tenders through the medium of a pinion engaging with teeth cut in the push-and-pull rods. In the tender for *Liverpool* the whole arrangement was much the same, with the difference that short levers, extending from the brake shaft, coupled up with the brake-rods, instead of the rack and pinion. Gooch's *Iron Duke* was similarly arranged. The whole of the gear is shown in the external elevation (Fig. 13), from which it will be seen that unlike the Great Western, the brakes were applied on the three right-hand wheels.

In the preceding article reference was made to discrepancies between the elevation and the sectional views given in the Tredgold plates. These differences appear most markedly in the tender, and the writer, having traced the external elevation, and in doing so put in, as he thought, all necessary corrections, discovered, when the drawing was completed, that the number of spokes shown in each wheel is only ten, whereas the sectional view drawn by David Glen, shows twelve which latter number is, of course, correct for a four-feet diameter wheel. Apologies are tendered, but the reader will agree that it was not necessary to remake the drawing in order to put the error right. It was by no means the only inaccuracy in the original plate.

The weight of the tender with fuel and full tanks was 21 tons. The tanks, of which there were three—two being underslung between the axles—had apparently a water capacity, as measured by the writer from

(*Continued on page* 481)

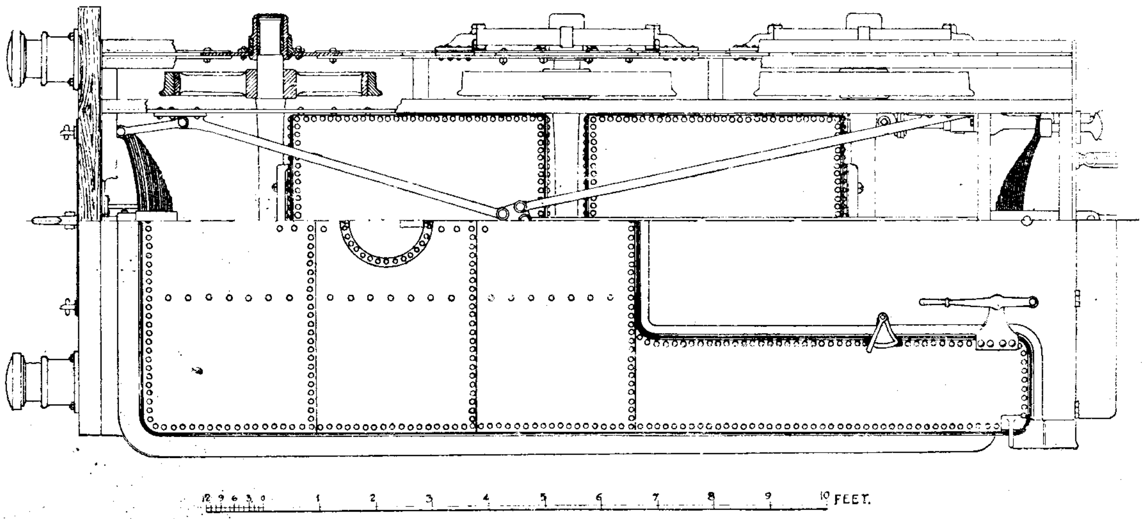
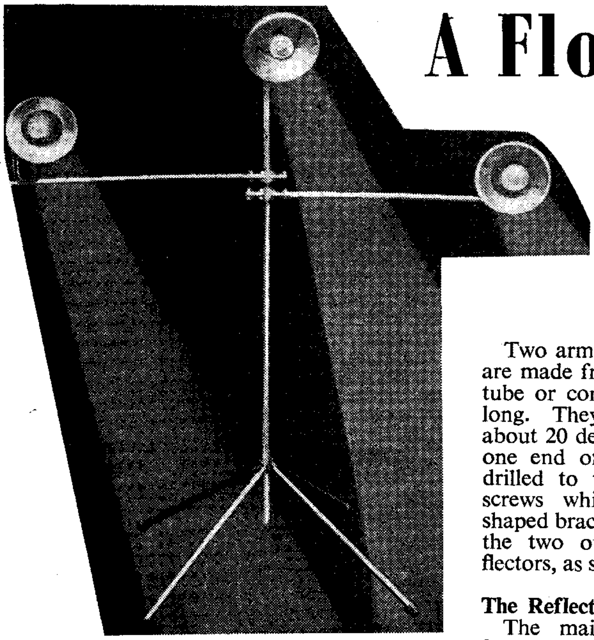


Fig. 15. *Half-plans of the tender*



A Floodlight Stand for Photography

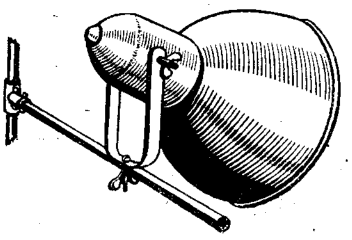
By Gordon Allen

FOR the ambitious photographer an adjustable light stand is indispensable. But the commercial types are very expensive, so here is a design which is not only easy to make but also " easy on the pocket."

Centre Stem

The centre stem of the stand is a piece of dural or hard wood $\frac{5}{8}$ in. diameter and 6 ft. long. Twelve inches from one end of this a $\frac{1}{4}$ in. diameter hole is drilled. This is to take a $\frac{1}{4}$ in. B.S.F. or Whitworth bolt, which in turn secures the four feet of the stand.

The latter are made from $\frac{1}{2}$ in. diameter conduit tubing. Four are cut $25\frac{1}{2}$ in. long and are trapped at one end for a distance of $1\frac{1}{2}$ in. The trapped ends are then drilled $\frac{1}{4}$ in. diameter and are bent to an angle of 45 degrees. A wing-nut, used in conjunction with the bolt, holds the feet to the centre stem as shown in the illustrations. Four lengths of rubber hose, cut as shown, and fitted over the ends of the feet give stability to the stand.



Two arms at the top of the stand are made from $\frac{3}{8}$ in. diameter dural tube or conduit and are each 3 ft. long. They are bent to an angle of about 20 degrees twelve inches from one end of each. Both arms are drilled to take 2-B.A. round-head screws which support the " U " shaped brackets. The latter support the two outrigger lamps and reflectors, as shown in Fig. 1.

The Reflectors

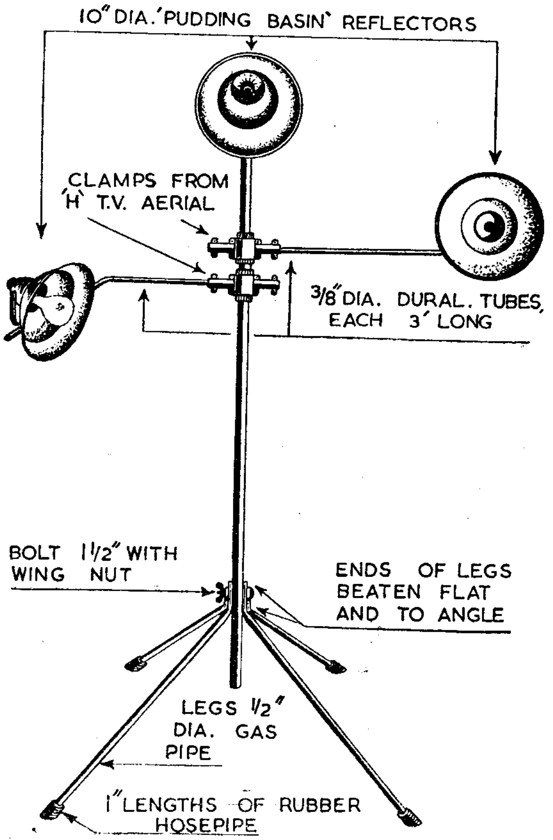
The main reflectors are made from aluminium pudding basins about 10 in. diameter. Holes are cut in the bottoms of the basins to make a neat fit for smaller basins of about 5 in. diameter. These, in turn, have their bases cut to take standard bulb holders.

The holes can be cut either with a small tool-maker's flat chisel, or by making a series of small drillings round the perimeter of the main hole and then joining them up, afterwards filing the ragged edge of the resulting hole.

The smaller basins are drilled at each side to take the adjusting-screws and wing-nuts shown in Fig. 2. Both basins are then joined by the liberal use of heatless solder applied in the form of a fillet right round the outside of the junction of the two units.

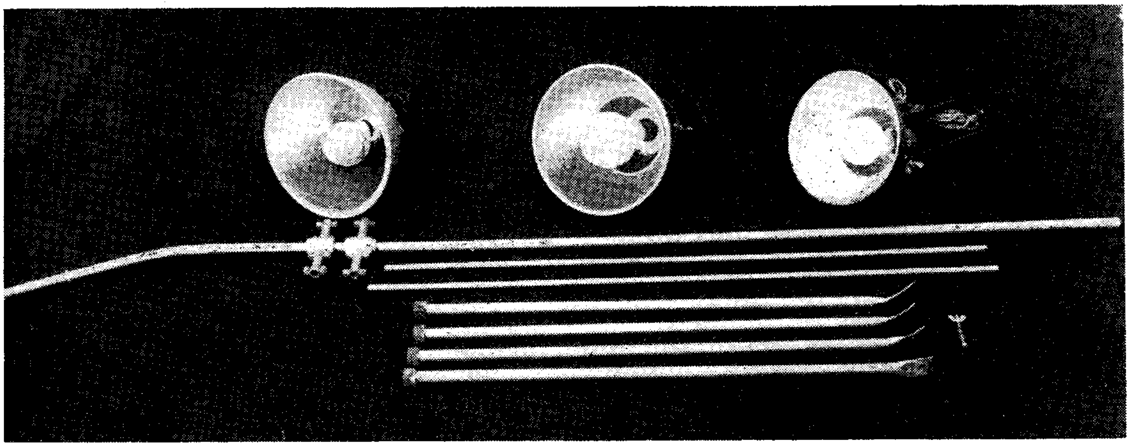
A similar principle is employed for making the top reflector. Here, however, the " U " shaped bracket, which is made from 1 in. by 16-s.w.g. dural or similar sheet metal, is screwed directly to the top of the centre stem of the stand.

Both outer arms are fixed to the centre stem by using clamps from an " H " type television aerial.



Right: Fig. 1. *Details of assembled stand. The four feet are secured by a single bolt and wing-nut*

Left: Fig. 2. *Each arm is fitted with a " U " shaped bracket on which the reflector is mounted*



The whole stand can be taken apart as shown here, for convenience in carrying

Two of these are necessary to ensure independent adjustment of each lamp.

Wiring

Wiring to the bulbs is done in the ordinary way, and the use of two-way adaptors ensures that varying combinations of lighting can be used.

The above photograph shows how the whole stand can be taken to pieces and stowed in a small space. In the original, it will be noted that the centre stem has been made from conduit and has been bent over at the top to give the lamp a normal forward tilt.

The whole unit can be made to look most attractive by giving it a coat of gold paint.

BRITISH CRAMPTON LOCOMOTIVES

(*Continued from page* 479)

the drawings, of 2,150 gallons. The wheelbase was equally divided and overall measured 10 ft. 6 in.

The rear buffers were, unlike those on the engine, of iron. At the front a large leaf spring, placed horizontally behind the wooden buffer beam, was long enough to span between the buffer centres and at its centre was coupled up to the drawbar hook.

It may be seen that in the longitudinal section, Fig. 14, a curved branch is taken out of the main water supply pipe leading to the flexible coupling between the tender and the engine; this branch seems to have led up to the footplate. Furthermore, there was a handle and rod with a bearing and bracket attached to the upper tank, in the fuel space. Neither the branch pipe nor the rod with its handle is shown in any other drawing and the writer can only suggest that the purposes served by both of these are one and the same, that is to say that the rod and handle worked a cock on the end of the pipe, above the footplate level to which end a hose could be be coupled for watering the fuel and washing down the footplates.

Colours

The rest of the constructional details are thought to be obvious, and this, therefore, concludes the description of this British Crampton engine. But, from both the historian's and the model maker's point of view, there is another rather important matter which ought to be dealt with; this is, the colour of the paintwork—or "livery," as it is often, erroneously called. In parenthesis the writer would like to say that he very much objects to this term "livery" as applied to the decoration of the king of all machines. It is undignified; it seems akin to the plush and knee-breeches of a flunkey and surely the stately locomotive is no flunkey.

Painting

But to resume the matter of painting of the *Liverpool*. The writer has a copy of a picture of this engine and the artist who painted the original, in oil colours, acting on the assumption that the Southern Division engines were painted red, has depicted the famous Crampton engine in a deep crimson colour. Now this is a mistake, for no Southern Division engines were red until Mr. McConnell commenced to paint his splendid "Bloomer" class of 2-2-2 singles, vermilion—like fire engines and Post Office pillar boxes—in the year 1860; two years after the *Liverpool* had been scrapped.

The fact is that all London and Birmingham Company's engines, and, after amalgamation, Southern Division engines, right from Bury's time up to 1860, were painted a middle-chrome green; very much like, or exactly like the Great Northern green of Patrick Stirling's time. They were picked out in black and fine lined white; but just how the picking out and lining was arranged on *Liverpool* the writer does not know. The tender tanks would be panelled, but whether in one long panel or in two, or perhaps in three shorter ones, is unknown. Wheels and framing of engine and tender were all green, the frames edged with black with a single white line. The boiler lagging plates were green as was the plating around the cylinders. Lagging bands were black edged with white lines.

The engines of the Northern Division were a darker shade, that known as "deep-chrome green," picked out with black and no fine lining, and this colour scheme will be applicable to the *Courier*. It is highly probable that all the Crampton engines which have been dealt with up to the present, in these articles were green; the Tulk and Ley South Easterns certainly were.

Aids to ACCURATE DRILLING

By " Duplex "

AN accurate drilling operation was required recently when making a batch of four components similar to that illustrated in Fig. 1. With the parts mounted in pairs on a shaft, it was important that the large side faces should lie flat when tested on the surface-plate. If the drilling is carried out in a haphazard manner by a beginner who does not appreciate the attendant difficulties, it is possible that the holes will not be placed centrally on the work and, as there is very little to spare when drilling a $\frac{5}{16}$-in. diameter hole in $\frac{3}{8}$-in. material, a very small error of centring may spoil the work. Moreover, where the holes are not drilled axially through the work, the parts may be useless for their intended purpose.

Marking-out the Work

The centre-lines for locating the drill holes can be marked-out with the jenny calipers, but there is less chance of error, and more certainty in attaining uniformity, if the lines are scribed with the surface gauge while the parts rest on the surface-plate. The scriber of the surface gauge is set as nearly as possible to the half thickness of the part, and a line is scribed along the work; the part is then turned over and a second line is drawn.

In the same way, when marking-out with the jenny calipers, two lines must be scribed from opposite sides in order to determine the true centre.

After the cross centre-line has been scribed, the appearance of the marked-out work may be like that shown in Fig. 2, and the next thing is to mark the drilling centres with the centre punch.

Forming the Drilling Centre

The centre punch itself must be accurately ground, and preferably honed, to a really sharp point at the apex of a cone, having an included angle of some 60 deg. for ordinary work. If the sight has lost some of its keenness, the use of a hand-glass will help to locate the point of the punch accurately on the work. However, a sharp punch can often be located in the scribed lines by feel alone.

The punch must be held vertically while being struck a controlled blow with a light hammer. The punch mark is next examined with the hand-glass to make sure that the indentation is symmetrically placed in relation to the centre-lines, as in Fig. 3.

If there is an error of centring, this is corrected by drawing over the punch mark. This is done, as represented in Fig. 4, by inclining the punch and striking a series of light blows while the punch is slowly moved into the vertical position; a final, heavier blow is then given to restore the true conical form of the indentation.

A tip worth remembering, for marking-out two mating parts individually, is to space the drilling centres on the first part with the dividers and to keep the dividers at the same setting for marking-out the second part.

Drilling Machine Accuracy

When work-pieces are held in an accurately-made machine vice resting on the drilling machine table, the true alignment of any holes drilled will depend on the accuracy of the machine itself and, if the machine table does not lie square with the axis of the drill spindle, the holes will be correspondingly out of line. It is advisable, therefore, in the present instance, to test the drilling machine, so that any lack of alignment can be corrected by the make-shift expedient of levelling the vice with packing strips.

This check is made by what is known as the turn-round test; that is to say, the dial test indicator is mounted on a pointed rod gripped in the drill chuck, and this plunger is brought into contact with the machine table as shown in Fig. 5. Normal drilling pressure is applied to the feed lever either by hand or by means of a suspended weight, and the drill spindle is slowly rotated by hand. The movement of the indicator needle will at once show if the table is out of square with the drill spindle, and by what amount. In an accurate machine, the recognised permissible error is 2-thou. in. per ft. measured at the sides of the table, and a further 1-thou. in. to 2-thou. in. rise at the front of the table to allow for wear and springing under load.

However, these fine limits can hardly be expected in the ordinary, inexpensive, commercial machine; but, as it happens, the small " Model Engineer " drilling machine, built in the workshop, shows no detectable error of alignment when the turn-round test is applied. If the table

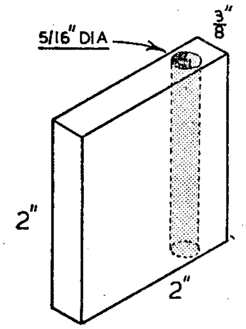


Fig 1. The finished work-piece

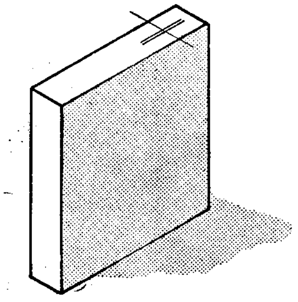


Fig. 2. The cross-centre lines are scribed on the work

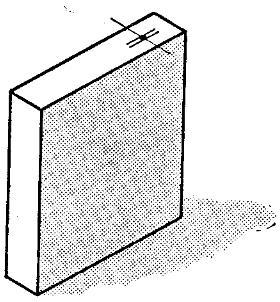


Fig. 3. The punch-mark is centred on the scribed lines

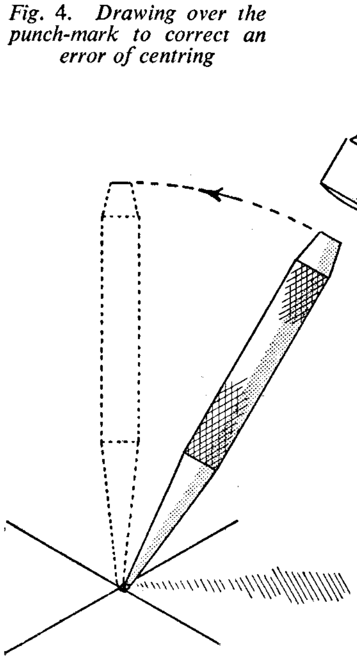
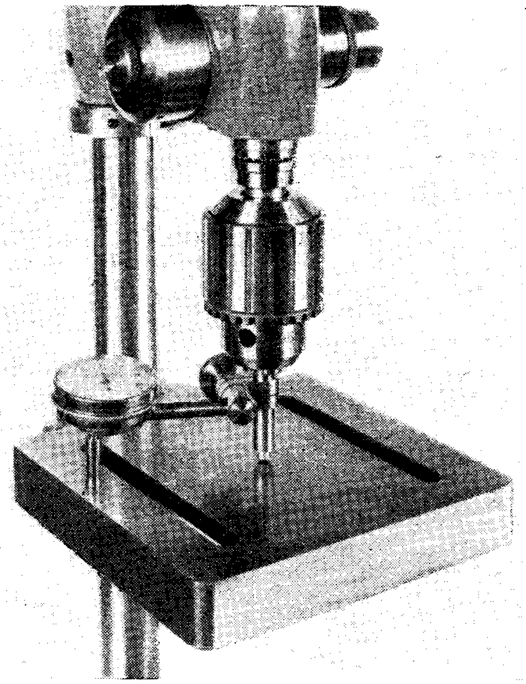


Fig. 4. Drawing over the punch-mark to correct an error of centring



Right: Fig. 5. The turn-round test for checking the accuracy of the drilling machine

of the drilling machine is, say, 4 in. in diameter and is out of square in one plane to the extent of 10-thou. in., measured at the extreme edge, then a hole 2 in. in depth will be drilled at its lower end 5-thou. in. out of alignment relative to the fixed jaw or work table of the machine vice.

Although this error may be of little or no importance in a shallow hole, there may be difficulty in erecting work where long holes are necessary; for if the drill hole in one part runs obliquely in one direction, and in the opposite direction in the mating part, then the two holes will have to be enlarged before a through bolt or spindle will pass. Where accuracy is essential, the usual practice of finishing the bore with a boring tool should be adopted; this may entail mounting the work on an angle-plate, attached to the lathe faceplate, and taking very light cuts with a long, slender tool. Alternatively, a D-bit can be used for this work, if started in a true-running hole formed with a boring tool.

Drilling the Holes

With the work held in the machine vice, the punch mark is first enlarged with a centre-drill having a point small enough to enter the depression. The hole so formed is further enlarged at its mouth with a second centre-drill up to the diameter of the final drill hole. In this way, a conical guide surface is provided for the drill point at starting, and the cutting edges do not have to rely on a sharp-edged hole for guidance. Next, a correctly ground pilot drill of, say, $\frac{3}{16}$ in. diameter is put right through the work, and this is followed by a drill of the reaming size. Finally, the hole is sized with a hand reamer, taking care to keep the reamer upright in order to avoid bell-mouthing the bore.

The ordinary, two-flute, twist drill is not ideal for enlarging a drilled hole, but the three-flute drills used commercially are hardly likely to be found in the small workshop.

Remember, too, that if the cutting edges of the drill are not symmetrically ground, the drill will tend to wander instead of following a straight path. As a check on the cutting edges, the shavings from the two lips should be identical in appearance.

When several similar work-pieces have to be drilled in this way, they can be gripped together in the machine vice and, if the position of the vice is kept constant, the holes are more likely to be uniformly aligned and any error will be maintained in the same direction.

For a final test, as illustrated in Fig. 6, the drilled parts are threaded on to a well-fitting, straight rod and the assembly is placed on the surface plate. If a straight-edge makes even contact with the upper surfaces of the components, it shows that the drill holes are correctly aligned in this direction; uniform contact between the edges of the parts will serve to check the work in the other plane. These are useful tests of both the skill of the worker and the quality of the machine equipment.

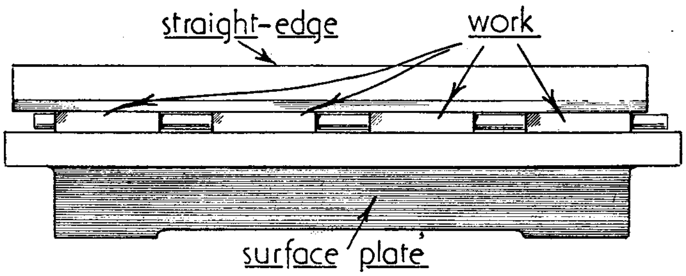


Fig. 6. A final test of the work on the surface-plate

AN EPICYCLIC BACK-GEAR
and some improvements

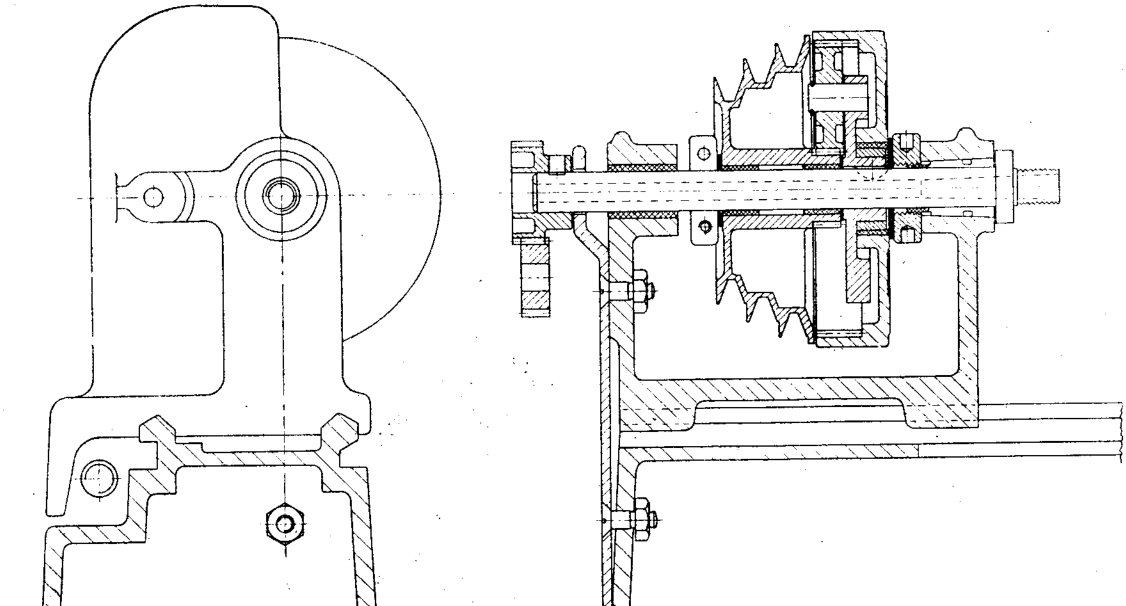
By L. V. P. Clarke (*Australia*)

THE writing of this article was prompted by the remarks of Mr. K. N. Harris in the issue of THE MODEL ENGINEER for June 18th in regard to the fitting of epicyclic gearing for lathe back-gears. A cheap 3 in. centre lathe, the "Courlan," was, and perhaps still is, made in the U.S.A. incorporating just such an epicyclic back-gear as he mentions.

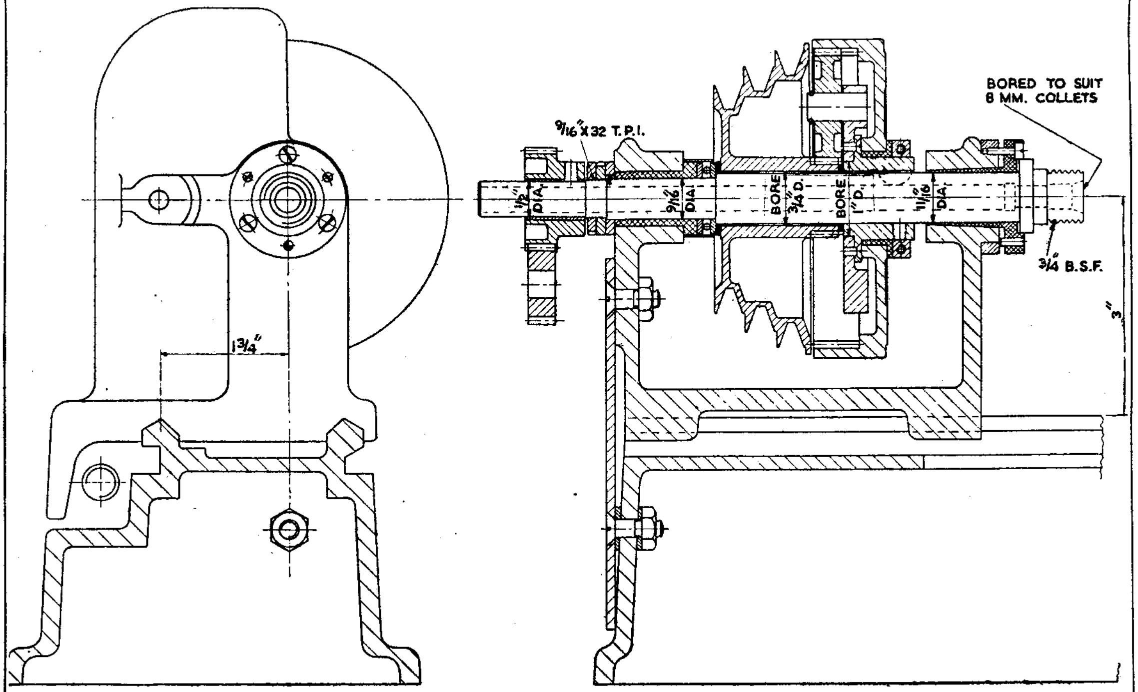
I had one of these lathes for some years and carried out a number of modifications to it, the drawings reproduced being made at the time. The drawing of the "Headstock in Original Condition" shows the arrangement of the back-gear. The spider carrying the three planet gears was keyed to the mandrel and on the outside of its centre boss was a steel sleeve. The bushed internally-toothed gear ran freely on this steel sleeve and could be locked to the planet spider by a sliding bolt or to the headstock by a round pin sliding in the headstock casting. The belt pulley was bushed and ran freely on the lathe mandrel and had, on its centre boss, the gear teeth comprising the sun gear. All these parts, that is, the spider, the planet gears, the internally-toothed gear and the belt pulley were zinc die-castings, and during the four years that I had the lathe they showed very little wear. The complete set of change wheels were also zinc die-castings, but the makers realised the limitations of zinc alloys and used iron for all the main castings of the lathe.

The principal change to the headstock was the fitting of a new mandrel. The original mandrel was 0.560 in. diameter and was hard chrome plated and ground, but was spoilt by the ½ in. diameter thread on the nose—the hole for the No. 0 Morse taper centre leaving only about 1/32 in. of metal at the root of the threads. The abutment collar was separate and screwed on to the mandrel. The front bearing was quite commendable, as it consisted of a tapered bronze bush, split for a part of its length only and pulled into the headstock casting by a ring-nut with a rather coarse thread. The rear bearing was not adjustable.

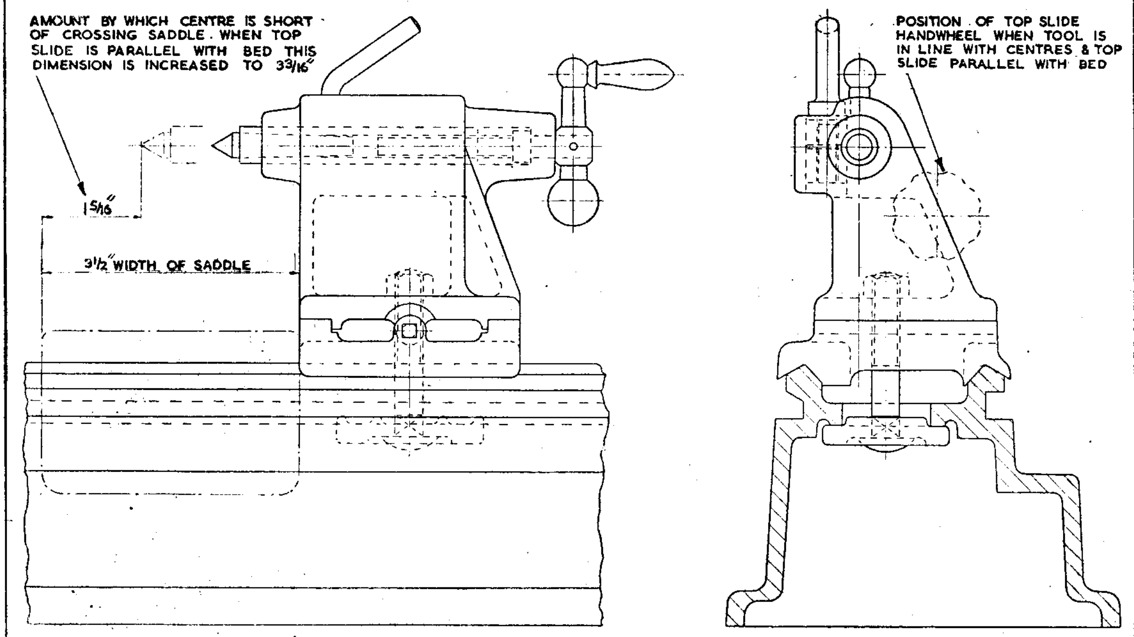
Due to the small diameter of the mandrel and the thinness of the nose, spring and chatter were most pronounced, even after the entire saddle and slides had been carefully refitted. The new mandrel was designed so that only minor alterations were required to the headstock casting, none of which would affect the alignment of the main bearing bores. It was found possible to increase the front portion of the mandrel to $\frac{11}{16}$ in. diameter by fitting a much thinner bronze bush. This was arranged to be pulled in by three cheese-headed screws or jacked out by three grub-screws. It was thus possible to lock the bush rigidly against axial movement—a desirable feature not possible with the original arrangement. To take these screws it was necessary to fit a steel ring around



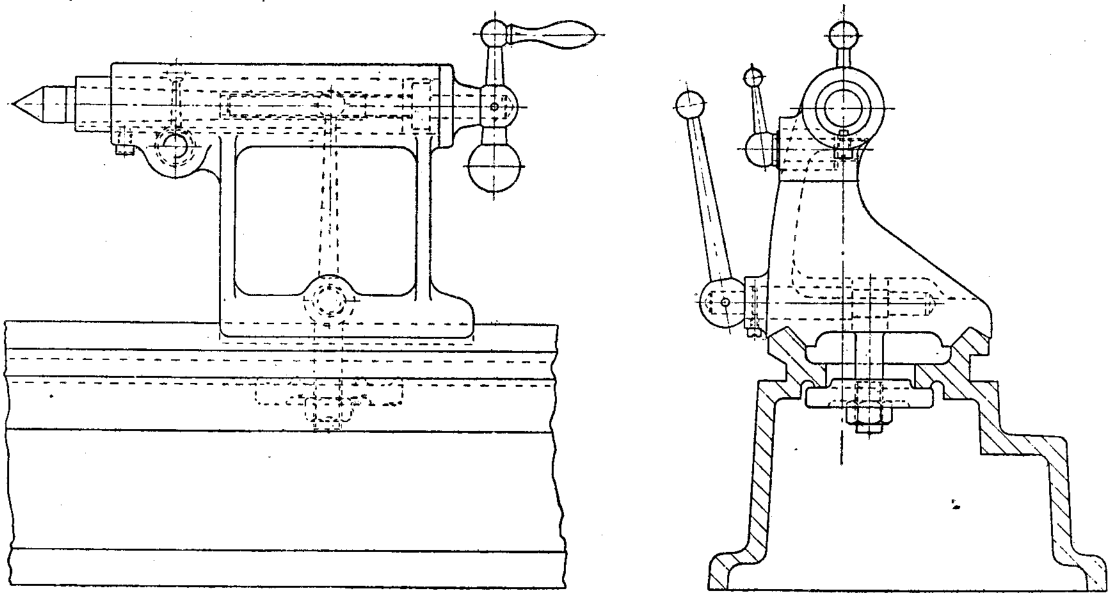
Part sectional elevations of the "Courlan" lathe headstock in its original condition



The headstock modified for larger mandrel



The lathe tailstock in its original condition



Modified design of the lathe tailstock

the front of the bearing boss. This was done by first filing the boss roughly circular and then truing it with a rather queer rig-up consisting of a turning tool sticking backwards through a slot of the faceplate. The ring was then shrunk on and the screw holes tapped half in the ring and half in the casting. The mandrel nose was screwed ¾ in. B.S.F., and was actually bored to take a ¾-length No. 1 Morse taper centre, and not for collets as on the drawing.

The centre boss was completely removed from the spider, and replaced by a steel one spigoted to it and attached by countersunk screws. The internally-toothed gear and the belt pulley were bored out and rebushed. This was an added advantage, as it was possible to eliminate the slight original eccentricity of these parts, resulting in a very much quieter back-gear. A ball thrust was fitted against the new rear bush, with the usual type of adjusting nuts. The mandrel was made somewhat longer than the original one, in order that it would project right through and beyond the change-wheel guard, making draw-bolts much handier to tighten.

The material for the new mandrel was 3 per cent. nickel-steel, chosen for its added rigidity and the fact that it will take on a hard surface glaze with use, giving almost the advantage of case-hardening. The improvement with this mandrel was most satisfactory and a deal of heavy motor-car work was carried out.

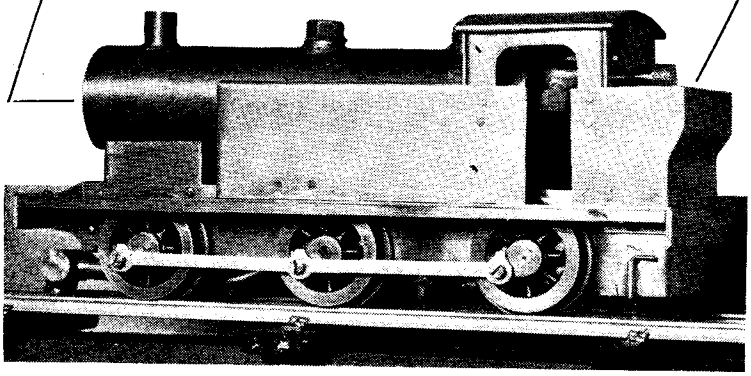
The tailstock had long been a source of annoyance, since it suffered from a fault common to many small lathes, but in this case in an acute form, due to the design of the casting. When turning a job between centres with an average length of tool and the top-slide set parallel with the bed, it was impossible to run the saddle back so that the top-slide passed alongside the tailstock. This was because the tailstock bulged out towards the *front* instead of towards the back of the lathe. Swinging the top-slide was an obvious solution, but with a job about ¾ in. diameter it was necessary to swing it through nearly 90°, and then its handwheel fouled that of the cross-slide. This trouble was aggravated by the very small projection of the front boss of the tailstock, and also less seriously by the small diameter of the poppet. It can be seen from the drawing that when the saddle was hard up to the tailstock, the poppet could not be advanced sufficiently to bring the point of the taper centre in line with the headstock side of the saddle. The net result of all this was that when turning a job between centres, it was necessary to mount the turning tool as far as possible to the right on the top-slide and turn part way up the job before running foul of the carrier or driver-pin. Then to move the saddle back, put the tool on the left or headstock end of the top-slide and complete the cut.

The new tailstock was intended to overcome all these faults, and at the same time incorporate a few additional improvements—such as the eccentric-type lock, with long ball lever, in place of the centre-bolt requiring a spanner. No provision was made for set-over for taper turning, as, apart from the difficulty of adjustment so that the lathe *will* turn parallel, I have never yet needed to set over a tailstock to turn a tapered job. Tapers are usually so short that they can easily be done by setting the top-slide to the angle required. It is admittedly, more difficult to ensure that the poppet is exactly in line with the headstock mandrel (and the bed), but in this case it was intended that the final boring should be done on the lathe itself, with the tailstock mounted on the bed.

Unfortunately, beyond getting the new casting, I was unable to complete the tailstock before having to dispose of the lathe, but from experience with a similar new tailstock for my re-built Super Adept lathe, I have no doubt that it would have done all that was required of it.

From the drawings it can be seen that the section of the lathe bed is rather unusual in that the top surface consists entirely of two raised "Vs" with no flat portion at all. Although not giving a large bearing area, it would seem adequate for the limited use that an average owner could give it, and it had the advantage that swarf would fall free of the slides more easily than with the usual flat bed.

A "Mollyette" By Donald D. Eames



IT all started with the approach of junior's birthday. After having a succession of clockwork locomotives, he expressed in no uncertain terms that he wanted one driven by real steam. A perusal of THE MODEL ENGINEER found that the most suitable was *Mollyette*, an "O"-gauge 0-6-0 tank engine. Although fairly simple and straightforward, she was miles ahead of the toyshop stage.

Construction went along fairly smoothly by following the "Words and Music." The cylinder was machined from a block of hard brass. The chassis, when finished was tested with a bicycle-pump and either buzzed or ticked over quite nicely. The little boiler was silver-soldered throughout by a Calor-gas hand torch, as also was the lamp. The wick tubes were a bit tricky. The top works were cut from 22-S.W.G. sheet brass.

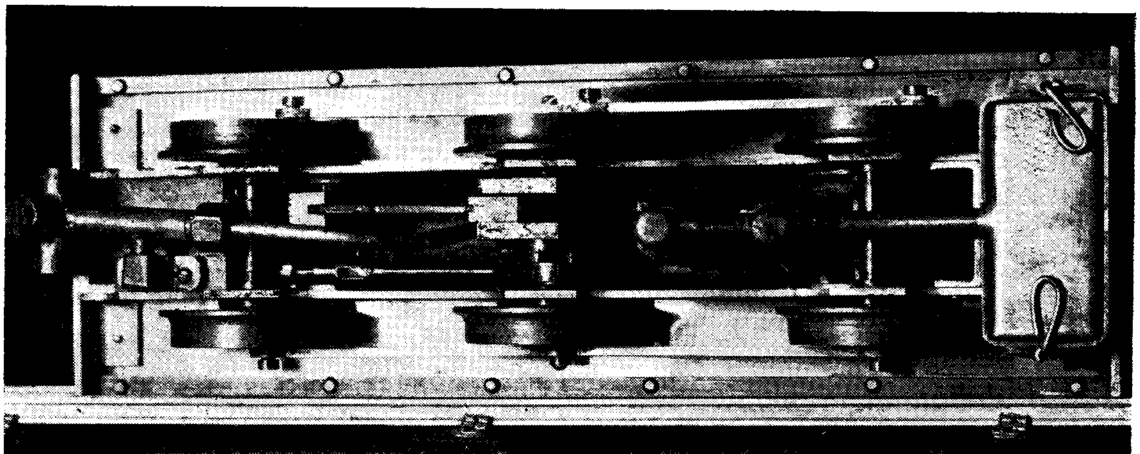
An 8 ft. diameter track was constructed in sections, using standard "O"-gauge rail section and cast chairs. The longitudinals and sleepers were cut from an egg box. The whole, after being stained, looked just the job.

Now for the first run under steam; and this is where the troubles started. The wick tubes were packed with asbestos yarn, the boiler filled with water and the lamp with methylated spirit. After lighting up, all seemed O.K. for about a minute; then it was noticed that the flames were getting smaller and the wicks were showing signs of charring. Examination showed things a bit cramped over the wick tubes, so the steam pipe which had been brought through the flames for "superheat" was bent over to one side. This improved matters slightly, but she would only make enough steam to proceed slowly a foot at a time on full throttle.

It was now thought that the wick tubes were packed too tightly, so they were thinned out. This, of course, was my undoing. Steam was raised very quickly and she was soon scooting round the track at an ever increasing speed, dropping little pools of burning methylated spirit on the floor. Next the cab caught alight, making it impossible to get at the regulator. Junior, by this time, was dancing up and down and yelling with delight, which brought the wife in to see what all the noise was about. She at once added to the hub-bub with loud cries of "stop the wretched thing," (as if I wasn't trying to) before it burnt the house down, etc., etc. It finally shot off the rails and was promptly doused amidst great excitement. Little damage was done, however, apart from my own burnt fingers. The lino, after polishing, showed very little effect of the "disaster," and this calmed the wife down considerably.

Now for *Molyette*. More space and air were obviously needed for

(*Continued on page* 491)



MORE UTILITY STEAM ENGINES

By Edgar T. Westbury

HAVING completed the machining of the components for the "Unicorn" engine as described in preceding articles, they may now be assembled, and this operation should be neither lengthy nor difficult if they have been made to reasonably accurate limits. Some of the parts have already been temporarily assembled in component groups, and need little more than mere attachment to the main structure, though slight positional adjustment may be called for; this applies to such assemblies as the governor and the feed pump.

The lining-up of the two main bearing pedestals has been dealt with, and if the crankshaft has been accurately made, it should run quite smoothly, though possibly a little on the tight side, which may be rectified by scraping down any high spots on the surfaces of the half-bearings. It is important that when finally fitted the top halves should be tightened firmly down, and not adjusted to running clearance by means of the nuts. The use of thin metal shims to take up any space between the brasses is permissible, but is best avoided in small bearings, as shims are often found more trouble than they are worth; in any case, the occasion to use them should not arise. Neither should it be found necessary, on the other hand, to rub down the bearing faces to take up excessive bearing clearance when fitting a new engine. Care taken in getting bearings to fit with silky smoothness, however, will always be repaid by efficiency and long life of bearings and engine generally.

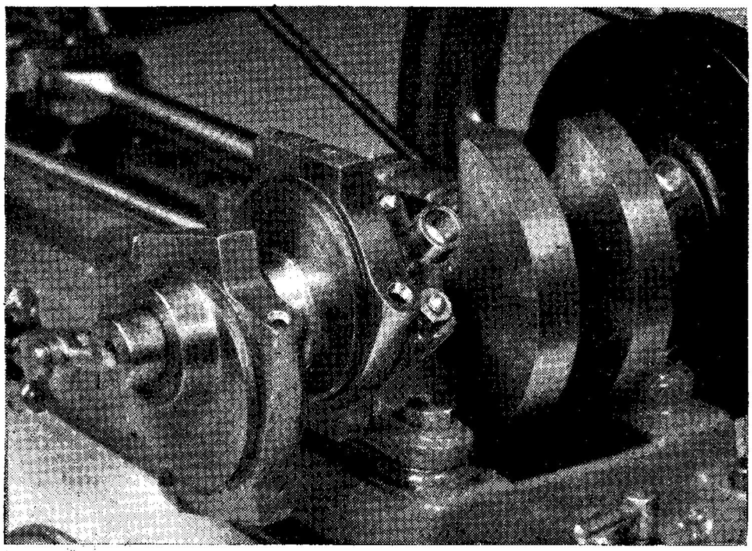
It may be found that the casting of the bedplate gives somewhat inadequate room for the crankshaft to turn without fouling the sides of the crankpit. If so, it will be necessary to clean these up by chipping or machining; in my case, I made a small cutter bar, large enough to take a ¼-in. silver-steel cutter, but turned down at the ends to ⅜ in. diameter to run in the main bearings. The bedplate was packed up on the lathe cross-slide to bring the bearings to centre height, and the bar set between centres for this operation.

After fitting the crankshaft, the crankhead bearing is bedded in and adjusted in the same way as the main bearings. With the connecting-rod in place, the crankshaft is rotated to check the alignment of the rod with the centre-line of the crosshead slideway. Should it be found to move parallel but off-centre, or at a slight angle, to this line, it is possible to correct this by adjustment of the location of the main bearing pedestals. But if the fork-end of the rod wobbles from side to side as the shaft is rotated, this indicates that the crankpin is not truly parallel with the shaft centre-line, and no fitting adjustment will correct the fault; the engine may be made to run by opening out the crankhead bearing to a sloppy fit, but it will never be mechanically efficient. I know of many engines, however, which are full of such faults, but continue to hobble along; and who am I to express intolerance if their constructors are satisfied?

The cylinder support bracket may now be erected and the crosshead fitted to the slideway, in which it should slide freely for the full working distance, and the fork-end of the connecting-rod should span the crosshead boss without forcing to either side. Before fitting the wrist-pin, however, it is advisable to erect the cylinder on the support bracket, as this may be more difficult afterwards. Although studs and nuts are the correct thing for mounting the cylinder, access to nuts in the recess of the bracket is by no means easy, and as they are in an unobtrusive position, it is permissible to use slotted-head screws—unless the engine is to be entered in an exhibition where the judges are somewhat "meticulous"!

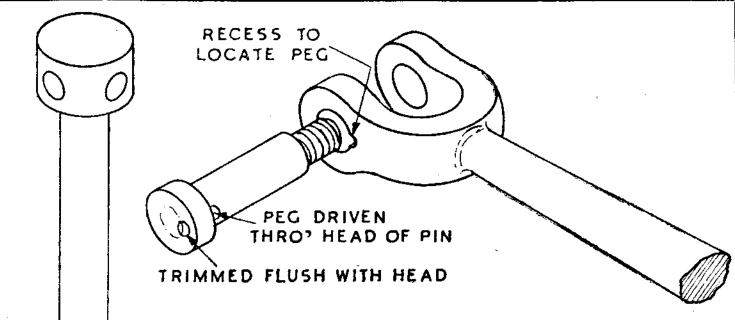
Incidentally, for dealing with nuts in funny little odd places, there used to be a very useful spanner—which I have many times had occasion to use in the cramped corners of a ship's engine room—known as a "clawfoot"; I have not seen one for many years, and wonder if it is still made. As its name implies, it resembled roughly the leg of a bird, having the open jaw at right-angles to the shank, the head of which was cross-drilled for a tommy bar. It would get into places where neither a plain set-spanner nor a box spanner could be used.

The crosshead may now be connected to the rod by the wrist-pin, and checked for smooth working by rotating the crank. It will



A close-up of the crankshaft end, with crank on outer dead centre

Continued from page 427, October 8, 1953.



Method of keying wrist-pin and knuckle-pins

Left: A "clawfoot" spanner for dealing with nuts in awkward places

be noted that the wrist-pin, having a round head, cannot be held securely for tightening its retaining nut. If it is a fairly tight fit in the fork of the rod, however, it will not be necessary to hold it. A washer should be interposed between the nut and the fork, and the former, when screwed firmly home, should not squeeze the fork in such a way as to jam the crosshead.

In full-size practice, however, it is usual to prevent wrist-pins and other pivot-pins turning by means of a "snug key," which in some cases consists of a round peg fitted to a cross hole immediately adjacent to the head of the pin, the head being filed square, and fitting a recess—it can hardly be called a keyway—in the fork. Such keys are not easy to fit in a small size, as practically the only way to produce the recess (unless it passes right through one side of the fork) is by chipping; and apart from this, the hole for the cross peg may weaken the wrist-pin. A more practical method is to fit the peg endwise by drilling from the head end, at a radius equal to that of the shank of the wrist-pin. This operation is carried out with the wrist-pin in place in the fork, so that the hole, after passing through the head, is half in each part. The peg, made from steel wire, or a small panel pin about 1/32 in. diameter, is slightly tapered so that it can be driven into the head to the required depth, then trimmed off flush, when it will be practically invisible from the outside.

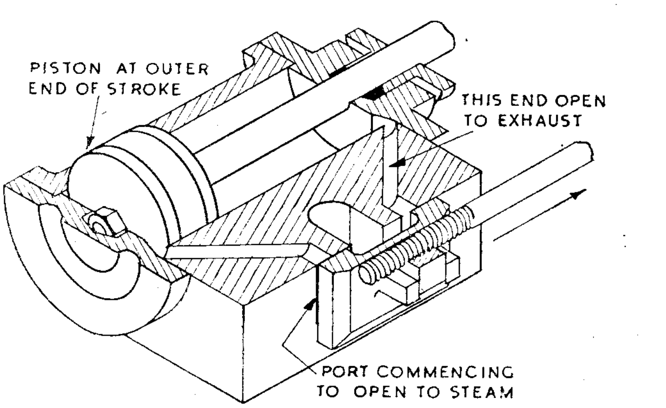
To avoid the risk of the nut slackening off, it is often castellated and split-pinned, but sometimes a plain nut is used, and after tightening is cross-drilled and taper-pinned. This is quite satisfactory for a job of this kind, where tightening the nut up to finality is not so important as ensuring that it doesn't slacken off.

Cylinder Assembly

It has already been noted that the length of the piston-rod may possibly have to be adjusted to ensure that the piston is correctly positioned, so as to give equal clearance at both ends of the stroke. To some of my readers, accustomed to modern production practice, such an injunction might appear indicative of slipshod workmanship; dimensions should, theoretically, be accurately predetermined, and as immutable as the law of the Medes and Persians. This, of course, is a necessity in cases where parts are produced in quantities, and have to be assembled with the minimum trouble; but it is only possible when *everything* in the assembly is made to specified limits, usually by jigging; and even so, we hear quite a lot about "adjusting washers," "location shims," and "selective assembly." In building a single engine, often without the use of precision measuring instruments, minute errors in dimensions of the various parts occur, even in the best regulated workshops, and may become cumulative or even multiplied. Thus some means of compensating errors must be allowed for, and I make no excuse for introducing it here; this explanation is, however, given for the benefit of those readers who are excessively "limit-conscious." Incidentally, I gave a detailed exposition of this subject, in relation to model engineering, in an article entitled "Limits—and Limitations!" two or three years ago.

If it should happen that the piston-rod is found to be too long, so that it gives insufficient clearance at the outer end of the stroke and too much at the inner end, the amount to be taken off can be determined by measurement; the clearance at each end should be 1/32 in., so that allowing $\frac{1}{16}$ in. for the cover spigot, the piston should enter to a depth of 3/32 in. from the outer end face when the crank is on outer dead-centre. If the dimensions of the essential parts are fairly accurate, no further check will be necessary, as slight difference in the clearance at the two ends does not have any serious effect on working efficiency; theoretically, it should be greatest at the inner end, to make up for the displacement volume of the piston-rod.

Should it happen that the piston-rod is too short to screw fully home in the crosshead (but not so short that insufficient thread is left to ensure firm fixing), it is permissible to insert in the crosshead a filling-piece of soft metal, such as a disc of copper or aluminium, blanked out with a wad punch, to take up the slack. It is important that the thread should pull up firmly; cross



Horizontal section of cylinder, showing position of slide-valve with piston at outer dead centre

pinning would prevent unscrewing, but would not remedy the mechanical insecurity of a slack thread.

As the piston may have to be tried in place two or three times, it is an advantage to drill two holes in the crown, not deep enough to cut into the packing groove, to take a pin-spanner. When the rod is adjusted, the piston may be packed with graphited asbestos yarn, and finally assembled, the gland also being packed, as described for the pump gland, but with asbestos packing. With regard to cylinder-head and steam-chest joints, only the thinnest material should be used for gaskets; I have found tracing linen very suitable for this purpose, as it is very tough, and when treated with gold size or one of the special joint varnishes, will stand anything except extremely high temperature, which will not be encountered here.

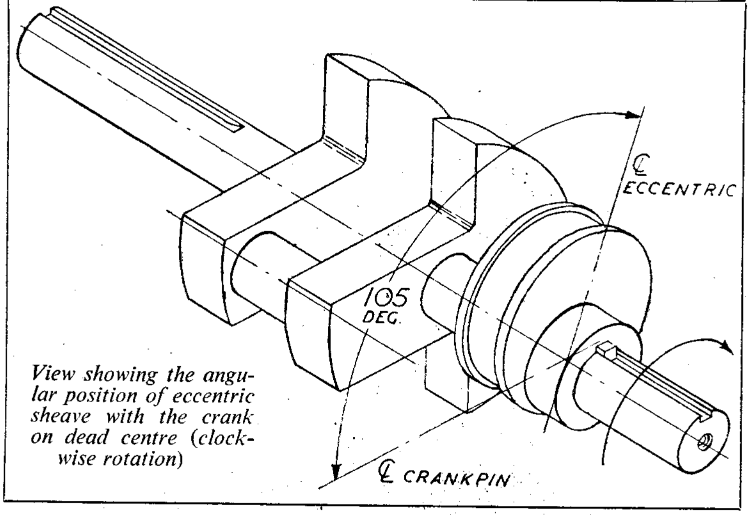
Valve Timing

The setting of the slide-valve is a matter which often worries the inexperienced constructor quite unnecessarily. I once heard a man who had made several steam engines, some of them fairly large, as models go, confess that he was never quite certain whether the valves were correctly timed. It is, of course, quite possible to set the eccentrics by angular measurement before the engine is erected, or even machine them integral with the shaft, but most constructors, I find, prefer to set them after assembly, if only because it is quite a tricky business to measure angles accurately, and even more so to work accurately to these angles, when the parts are small.

I recommended that the valve eccentric should be made a wringing fit on the crankshaft, so that it would be tight enough to operate the valve, yet capable of being shifted without using undue force. If, however, this condition cannot be fulfilled, a thin tapered key can be used to wedge the sleeve, or the boss of the sheave can be drilled, and a small grub-screw fitted in a position where it will not foul the keyway (if any), such as in line with the throw axis, or "dead-centre" of the eccentric. The parts may now be assembled and the slide-valve temporarily connected up; the eccentric-rod should drop into the valve-rod fork without the need for forcing it sideways, but if not, any discrepancy in this respect should be corrected, so that it lines up accurately.

The first thing to ensure is that the movement of the slide-valve is symmetrical relative to the cylinder ports. This can be checked visually by removing the steam-chest cover, the steam-chest being kept in place temporarily by two or more of the securing nuts, with distance-pieces if necessary. Adjust the location of the valve, by screwing the rod in or out, so that it opens the cylinder ports equally at the two ends of the eccentric stroke; this may be measured by means of a tapered gauge filed up from sheet metal, which should enter to the same depth in each port.

Having done this, the eccentric position may be set, by placing the crank on either dead-centre, and shifting the eccentric sheave in advance of the crank, in the direction of rotation, to such an extent that the cylinder port at the end corresponding to the crank position is just beginning to open. In an engine of this type, only the merest trace of opening should be allowed; if it must be measured, use the thinnest feeler in the pack, usually $1\frac{1}{2}$-thou. When the crank is turned to the opposite dead centre, the other cylinder port should show exactly the same amount of opening, if the position adjustment of the valve is correct.

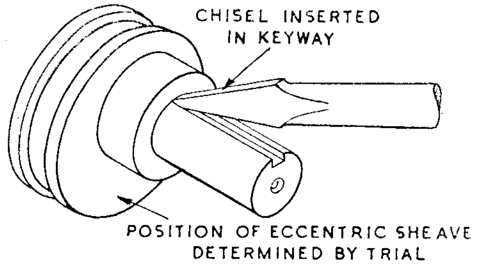


View showing the angular position of eccentric sheave with the crank on dead centre (clockwise rotation)

"Elementary, My Dear Watson!"

Perhaps I should apologise to readers for this elementary description of valve setting, as a very large proportion of them apparently learned to set a slide-valve before they learned to walk. But there are always "the others"—and they are more numerous than some of us think. For their benefit, it may be explained that the amount of valve opening which takes place before dead-centre of the crank is known as "lead," and needs to be least on slow-speed engines and greatest on high-speed engines. The amount of valve movement, from the end of the eccentric stroke, which takes place before the cylinder port starts to open, is known as "lap," and it reduces the period during which the port is open, so that the steam can be used expansively in the cylinder for reasons of economy. If the valve had no lap or lead, the eccentric sheave would be set exactly at 90 deg. in advance of the crank, so that the steam would be admitted to the cylinder exactly at the beginning of the piston stroke, and cut off exactly at the end, the exhaust events being timed the same, but in reverse order. When lap and lead are introduced, the eccentric must be advanced further to make up for the amount of movement which takes place before the cylinder port starts to open: the angular setting on an engine of this type is usually about 105 deg. in advance of the crank. The exhaust cavity which controls the escape of used steam through the inside of the valve, is usually arranged to give a full 180 deg. of effective opening (sometimes more), but displaced in relation to piston movement, according to the angle of advance over and above 90 deg. These rules are generally applicable to all slide-valve engines, but may be modified to some extent when link motion or other variable-expansion gear is used.

The direction of rotation, in non-reversible stationary engines, is usually arranged so that the crankpin is uppermost on the outward stroke, or as one of our Northern correspondents expressed it some



Method of locating the position of the keyway in the eccentric sheave

time ago, " oot o' t'hoose."

Keying the Eccentric Sheave

As previously mentioned, constructors may be quite content to rely on a grub-screw to drive the eccentric, in which case, after once its position has been determined, a " dimple " may be drilled in the shaft to take the point of the screw and provide positive location; the head of the screw should be sunk flush with the surface of the boss. If a keyway has been cut in the shaft, however, a corresponding internal keyway in the eccentric sheave must be cut, using methods which have already been described, and it is most important that this should be located exactly in the right place. It is by no means easy to mark this position really accurately or to set it at the correct angle when planing the keyway, but the method which I employ very much simplifies these operations. I make a small tool similar to a cross-cut chisel, $\frac{1}{16}$ in. wide to fit the keyway in the shaft, and fine enough to wedge into the boss of the sheave, but obtuse enough to avoid jamming. When the eccentric has been set, this tool is driven into the keyway by a couple of sharp taps with a hammer, producing a small but quite distinct impression on the face of the sheave. When the latter is held in the lathe for cutting the keyway, the planing tool can be lined up accurately with this mark with the aid of a lens.

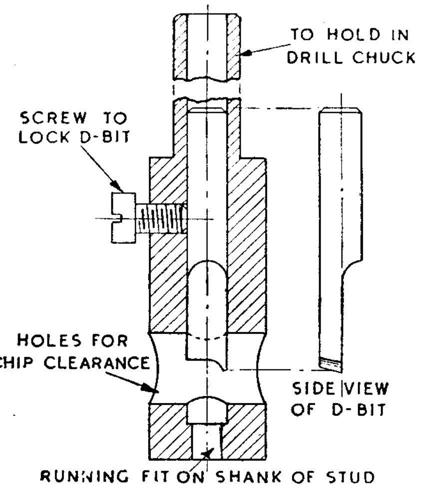
The pump eccentric and flywheel can also be similarly keyed, the latter having a headed key which projects on the outside, so as to facilitate removal; the location of the keyways in these parts is not critical. Keys should fit closely sideways, but not be too tight top and bottom.

Fitting the governor and feed pump are straightforward jobs which should not need detail instructions. The governor pulley should line up with the drive pulley on the shaft, and if necessary the pulley boss may be skimmed or spaced out from the bearing by fitting a washer—not by allowing end play on the shaft. It may be found desirable to pack the mounting plate of the feed pump to line it up properly with the eccentric, or to space the latter out a little from the valve eccentric.

Fitting Studs

In nearly all cases the most suitable fixings for the components are studs and nuts, but the making and fitting of studs is a fiddling job which is often shirked by constructors. The use of screwed rod, or " studding," which can be bought in lengths, is only just permissible on the grounds that " it does not show "; it is, however, rather difficult to obtain mild-steel rod of the correct size for making proper studs in B.A. sizes, except 5 B.A. and 7 B.A., which are almost exactly $\frac{1}{8}$ in. and 3/32 in. respectively.

To fit studs, it is advisable to use the proper tool, which is known as a " stud box," and is easily made by drilling and tapping a length of hexagon steel rod, and fitting a set-screw and lock-nut. (I have never seen such tools obtainable ready-made for small size studs.)



Enlarged view of a simple tool for trimming the ends of studs

When the studs are fitted, it will usually be found that in spite of all precautions to the contrary, they will project unevenly, and will need to be trimmed to the same length. If simply filed off, it will be next to impossible to round the ends really neatly, but this can be done with the aid of a simple tool which can be used in the drilling machine or hand brace. It consists of a holder with a shank to hold in the chuck, drilled a running fit for the stud, and fitted with an adjustable cutter, in the form of a D-bit with the end shaped so as to round off the stud, the end of the holder serving as a stop to ensure that all studs are finished to the same length.

The studs for main bearings, crankhead, and glands should be double-nutted to avoid risk of slackening, the outer nut being made thinner, to reduce the space occupied on the stud.

(*To be continued*)

A " MOLLYETTE"

(*Continued from page* 487)

the burners, and it was noticed that the three water-tubes were lower than they should be, so they were bent up nearer the boiler. The wick tubes were reduced in length and repacked as they were originally. Diplomatic overtures were started on the home front, and permission was granted for another steam-up. This was wholly successful with *Mollyette* behaving herself and responding to the regulator as she should.

Although my primary interest in model engineering is stationary engines, I got a lot of fun building this little engine, and at the present time am half-way through building *Rainhill* which I hope will pull me up and down the club track, perhaps even with passengers; who knows? I should like to pay a tribute to " L.B.S.C." whose hints and tips are useful to all branches of model engineering.

Both of the photographs of the engine, taken by myself, show signs of the conflagration.

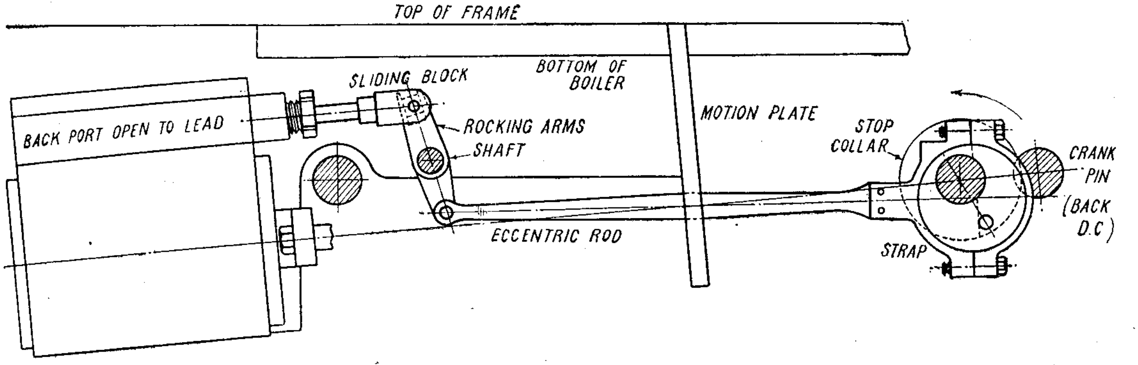
L.B.S.C.'s *Titfield Thunderbolt*

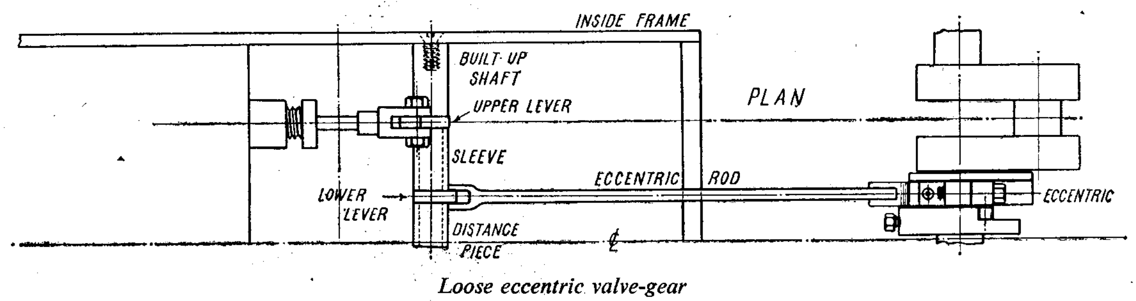
IN 3½ AND 5 INCH GAUGES

IN the brief specification of the locomotive, in the first instalment of this serial, I mentioned that I would give descriptions of both loose-eccentric valve-gear, and the gab motion as fitted to the old "ancient and honourable," with drawings to suit; so here goes to fulfil that promise. Whilst the gab motion is very ingenious, and of historical interest, it presents no advantages on the little engine, from an efficiency point of view, as it cannot be notched up; so I strongly recommend the loose-eccentric gear for use on a continuous line, where constant reversing is not needed. The complete layout of this, is shown in the accompanying general arrangement drawings, and is virtually the same for both the 3½-in. and 5-in. gauge engines. I certainly don't agree with the idea that the general arrangement drawing of a valve-gear is not necessary, because very often, a drawing shows, at a glance, details that could not be satisfactorily explained in pages of words. Also, if anybody bought a set of blueprints for a locomotive, and found no general arrangement of the valve-gear in them, they would, in the lingo of the running sheds, be "properly sold a pup" when attempting to erect the parts.

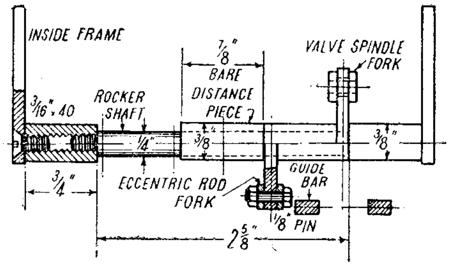
Simplicity

In an endeavour to cut the valve-gear to the rock-bottom of simplicity, I made a tentative drawing of it, without any rocking-shafts, and the eccentric-rods connected to the valve-spindle forks direct; this arrangement has answered perfectly for years, on my old 4-4-2 L.N.W.R. tank engine *Olga*. The few good folk who have driven her, can testify to her performance! However, on the "Tit" it somehow looked "all wrong," possibly because of the upward slant of the cylinders; and as the full-sized engine had rocking-shafts, I had another shot, and put them in. To keep them in approximately the same position as on not-so-big sister, I dispensed with any separate connecting-link between the top of the rocker and the valve spindle fork, and coupled them direct, using a sliding die-block in the rocker arm, to overcome the trouble of the spindle having a straight-line movement, whilst the top of the rocker moved in an arc; the arrangement shown, is very similar to the connection at the right-hand end of the Holcroft gear on my *Tugboat Annie*. This has never given a moment's trouble.

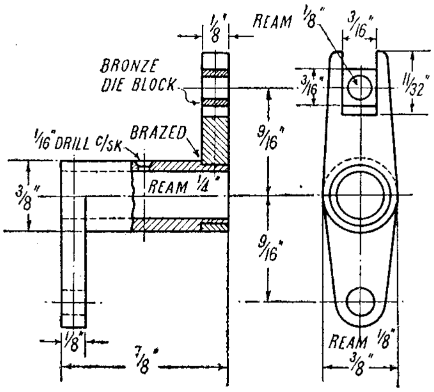




Loose eccentric valve-gear



Rocker and shaft for the 5-in. gauge engine



Right: Rocker assembly for the 5-in. gauge engine

On the full-sized engine, the rockers were carried on a weird and wonderful arrangement of brackets attached to the cylinders and frame. Here again, I have been able to simplify matters, and the rockers are mounted on a single cross-shaft between the inside frames, just above the guide bars. The arms are fixed to a short sleeve, one in line with the valve spindle, and the other in line with the end of the eccentric-rod. So much for that; now to business.

Cross-shaft and Rockers

The shaft on which the rocker sleeves work, is built up in three pieces on both the $3\frac{1}{2}$-in. and 5-in. gauge engines. To make the smaller one, part off two pieces of $\frac{1}{4}$-in. round mild-steel rod, $\frac{9}{16}$ in. long. Chuck truly in the three-jaw, centre-drill through with No. 40 drill, and tap $\frac{1}{8}$ in. or 5 B.A. about half-way through. Reverse in chuck, open out with No. 30 drill for $\frac{1}{4}$ in. depth, and tap 5/32 in. × 40. Face off each end truly, so that the overall length is exactly 17/32 in.

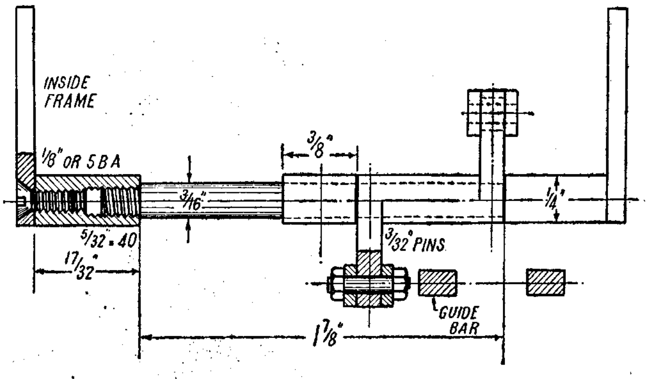
For the centre section, part off a piece of $\frac{3}{16}$ in. round mild-steel rod $2\frac{1}{4}$ in. long. Chuck in three-jaw, turn down $\frac{3}{16}$ in. of each end to 5/32 in. diameter, and screw 5/32 in. × 40. Reverse in chuck, and repeat operation, leaving just $1\frac{7}{8}$ in. between the shoulders.

For the rocker sleeves, part off two $\frac{3}{4}$ in. lengths of $\frac{1}{4}$ in. round mild-steel rod; for the distance-piece, one $\frac{3}{8}$ in. length of the same material. Chuck each in the three-jaw, centre, drill through with No. 14 drill, and ream $\frac{3}{16}$ in. The levers can be cut from $\frac{3}{4}$ in. lengths of $\frac{1}{8}$ in. × $\frac{1}{4}$ in. mild-steel strip, or from any odd bits of $\frac{1}{8}$-in. steel left over from frames. The lower levers are of the usual shape, slightly tapered, with rounded ends; drill two No. 48 holes at $\frac{7}{16}$ in. centres, ream one 3/32 in. and open out the other with a 7/32-in. drill. Watch your step on that last bit, as there won't be much metal left around the hole! The upper levers are left straight, a slot 5/32 in. wide and $\frac{1}{4}$ in. deep, being cut in the top as shown; round off the corners. The other end has a 7/32-in. hole in it. Turn down $\frac{1}{8}$ in. of the ends of the $\frac{3}{4}$-in. pieces of $\frac{1}{4}$-in. reamed rod, to fit tightly in the 7/32-in. holes in the ends of the levers. Squeeze a slotted arm on one end, and a tapered arm on the other, setting them exactly opposite, and braze the joints. After cleaning up, drill a $\frac{1}{16}$-in. oil hole in the middle of each, and countersink it; then poke the $\frac{3}{16}$-in. reamer through, to remove any burrs, and true up the hole. Thin steel bushes and sleeves sometimes distort when heated for brazing.

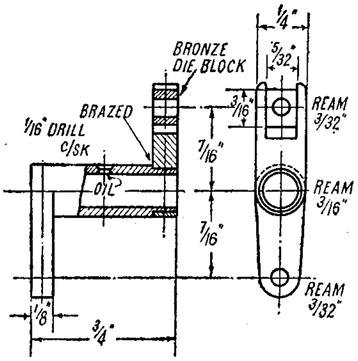
How to Assemble

First screw one of the end pieces on to the middle section, right up to the shoulder. Put on one of the rocker assemblies, with the slotted lever next to the shoulder; then the distance-piece, and after that, the other rocker assembly, tapered end first. When the other end piece is screwed on, right up to the shoulder, the rockers should be able to oscillate freely, without any end play; if they are tight, take a weeny shade off the end of the distance-piece. The overall length of the complete doings, should be exactly $2\frac{15}{16}$ in. to fit between the inside frames.

The rocking-shaft assembly for



The $3\frac{1}{2}$-in. gauge engine rocker and shaft



Rocker assembly for the $3\frac{1}{2}$-in. gauge engine

the 5-in. gauge engine is made up in exactly the same way, but to the dimensions given in the drawing. The end pieces, distance-pieces, and rocker sleeves, are all made from $\frac{3}{8}$-in. round mild-steel rod, and the centre section from $\frac{1}{4}$ in. ditto. The end pieces are drilled 5/32 in. or No. 22, and tapped $\frac{3}{16}$ in. × 40 right through, the ends of the centre section being reduced and screwed to suit. The die-blocks for both sizes can be made from $\frac{1}{8}$ in. × $\frac{3}{16}$ in. bronze rod, or filed up from $\frac{1}{8}$-in. slices parted off from a piece of $\frac{5}{16}$ in. drawn bronze rod. In the latter case, centre and drill the rod before parting-off, using No. 44 drill for the smaller, and No. 34 for the larger. Ream the holes after fitting the die-blocks to the levers; it's easier !

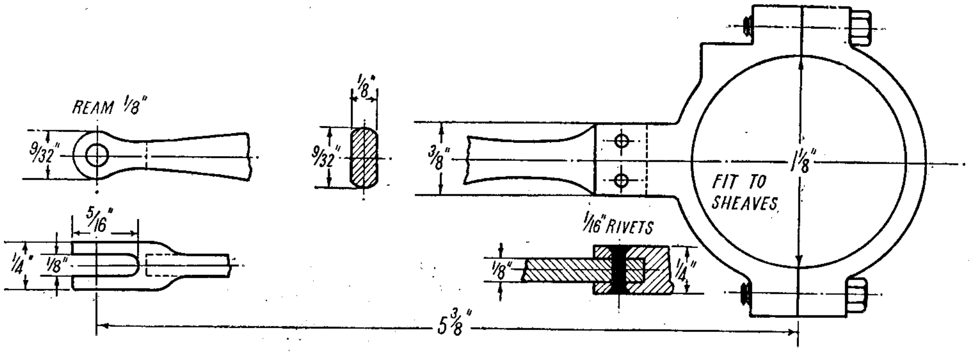
The eccentric straps can be made from castings, as usual; although I have shown them with extended lugs for the rods, as on the full-sized engine, these are not essential, and the ordinary type will do just as well. The castings are machined in exactly the same way as for other modern-type engines described in these notes. Clean up with a file, drill the lugs with No. 44 drill, and saw across the middle of the lugs, using the vice top as a guide. Open out the holes in the ring half, with No. 34 drill, and tap the holes in the lug half, 6 B.A. Smooth off the saw marks, and screw the halves together, marking each pair, so that they don't get mixed up. Chuck in the four-jaw with the core-hole running as truly as possible; face off one side, and bore out to fit the sheaves. To face the other side, either clamp the strap on a stub mandrel held in the three-jaw, or else hold it on the inside jaws of a little chuck. I fitted a little three-jaw 2 in. diameter, to my Boley lathe, and find it very handy for this sort of antic. Note that the eccentric-straps for both sizes of engine are the same width, viz.: $\frac{1}{4}$ in. The larger one has a slot $\frac{1}{8}$ in. wide, cut in the lug, for the attachment of the eccentric rod; but the $3\frac{1}{2}$ in. one is rebated for half its thickness, to keep the rod straight. The fork is also offset, as otherwise it would run foul of the guide bars. The clearances are shown in the drawings.

Ancient Appearance

The eccentric-rods are in keeping with the other rods on the engine; what a wee acquaintance of mine would call "fat in the miggel an' fin at the ends." Those on the full-sized engine are also circular in section; but here again, the small ones would be too frail if made thus, so the only thing to do, is to adopt the same wheeze used for the coupling and connecting-rods, and make them flat with rounded edges, if you want to preserve the ancient appearance. If they are turned to shape between centres, be mighty careful, and take very light cuts, otherwise such long flimsy rods will spring out of the lathe centres. They could easily be filed to the given shape, and the tops and bottoms rounded off. The forks at the ends can be formed by brazing on little blocks of mild-steel, slotted and filed to shape after they are cleaned up; a job I have described "many a time and oft," in connection with the valve-gears of modern locomotives dealt with in these notes. Of course, the whole blessed lot could be cut from the solid bar, $\frac{5}{16}$ in. square for the 5-in. gauge engine, and $\frac{1}{4}$ in. square for the $3\frac{1}{2}$-in. job, by anybody having the necessary time and patience; but the net result wouldn't show any gain in efficiency, as far as working is concerned, although it would probably gain marks at any exhibition, or look pretty in a glass case in the museum. Personally, I wouldn't bother about the fancy shape at all, life being too short, but would just make the rods straight, as in a modern engine; and anybody who doesn't care a brass button for what Inspector Meticulous says or thinks, as long as the engine does the job, can do the same, with Curly's blessing ! The most important thing is to make quite certain that the rods are the exact length between the centre of the eccentric-strap, and the pinholes in the fork; this can be ensured by making the bit of rod that fits into the lug on the strap, a little over-length at first, and then carefully filing the end, so that when it is right home, as shown in plan, the centres are O.K. It can be fixed temporarily with a little solder, to hold the parts in position whilst being riveted; after which, heat it enough to let the solder sweat right through, and clean off any surplus.

How to Assemble the Valve-gear

Builders will recall that I said don't fix the cylinders permanently, as they would have to be removed to erect the valve-gear. If you have put the nuts on the spigots at the motion-plate end of the guide bars, take them off, also remove the temporary cylinder fixing screws, and slide the cylinders out. Also drop the leading wheels far enough to get at the holes in the frame, just behind the leading axle. Countersink these holes, and then put the rocking-shaft assembly between the frames, in line with them; secure with a countersunk screw at each end. See plan, and cross-section of shaft erected. Ordinary commercial screws can be used on the $3\frac{1}{2}$-in. gauge engine, but special ones

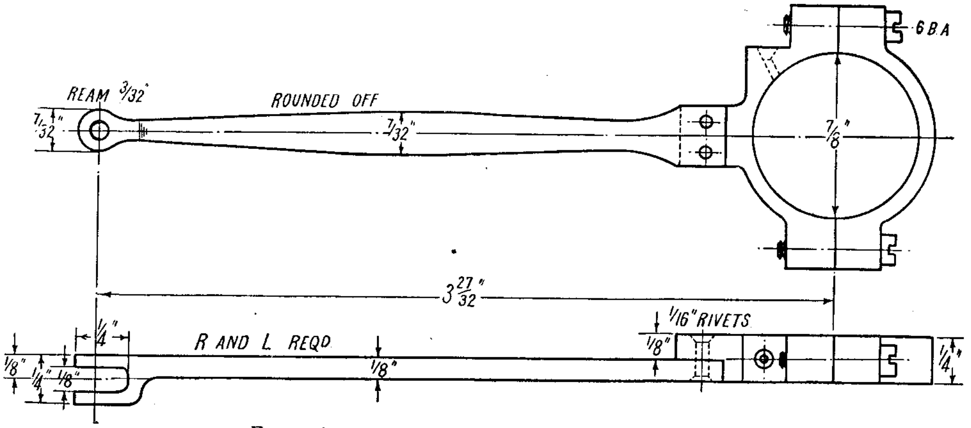


Eccentric strap and rod for the 5-in. gauge engine

must be turned from $\frac{5}{16}$-in. round mild-steel rod, for the 5-in. gauge job, as $\frac{3}{16}$ in. × 40-thread screws are not made commercially. However, that is simple, but the threads mustn't be slack, or the screws might work loose when the engine is in service.

Replace cylinders and wheels. Take the eccentric-straps apart, put the ports an equal amount at each end of their movement, adjust the forks on the valve spindles until they do. Then set one of the cranks on front dead-centre. Slacken the set-screw in the stop-collar, give it one complete turn forward, to make certain that it is driving the pin in the eccentric, and continue turning until the valve is at the extreme the thickness of this, keep turning the wheels until the port cracks, then turn back until the crank is on dead-centre. The distance between the shoulder, and the stop pin in the eccentric, is the required thickness of the make-up piece.

If the ports crack *before* reaching the dead centres, the shoulder of the stop-collar isn't cut back far



Eccentric strap and rod for the $3\frac{1}{2}$-in. gauge engine

them on the sheaves, and bolt up; make certain that they are quite free without being slack. The forks can then be attached to the lower ends of the rocking levers, by pins made from 3/32-in. or $\frac{1}{8}$-in. round silver-steel, according to size of engine. The ends of the larger ones can be turned down to 7/64 in. and screwed 6 B.A., for sake of neatness, and the smaller ones reduced and screwed 8 or 9 B.A. Note—Leave one of the bottom pins a full $\frac{1}{8}$ in. over length, as it will be used for the drive to the mechanical lubricator.

Put the die-blocks in the slots in the upper levers, and slide the valve-spindle forks over them, pinning through fork and die-block with silver-steel pins made as above. The pins should turn easily by finger-pressure alone, when the nuts are screwed home tightly, otherwise the jaws of the forks may be pinched in, and cause unnecessary friction. After coupling up, turn the wheels by hand, and make quite sure that everything is free; there should be no tight places anywhere.

How to Set the Valves

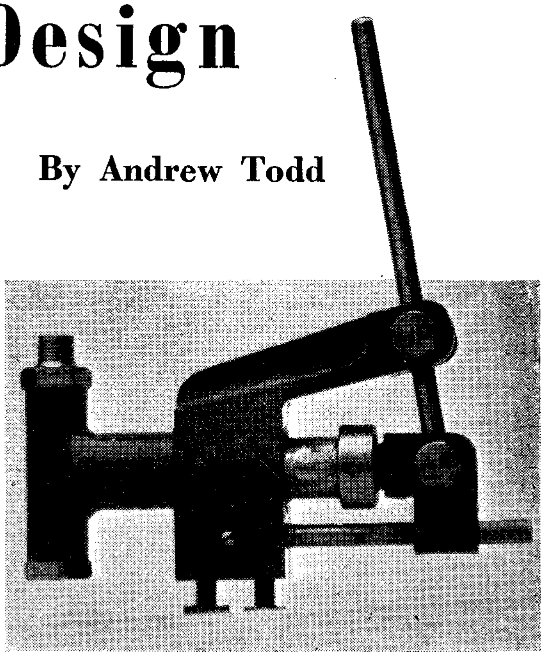
Tighten up the set-screws in the stop-collars just enough to allow the latter to drive the eccentrics; any position on the axle will do. Take off the steam-chest cover, turn the wheels slowly by hand, and watch the valves. If they don't uncover end of its travel, as near as it can go to the front wall of the steam-chest. Now watch the valve like pussy watching a mouse hole, and keep turning very slowly. As soon as a thin black line appears at the edge of the valve, stop turning, and tighten the set-screw in the stop collar. Next, turn the wheels in a forward direction until the crank is on back dead-centre. If the black line isn't showing at the back end of the valve, same is too long; I have allowed extra for this in the given dimensions, as it is best to get the exact length of valve from the actual job. Continue turning, and note how far the valve has to move before the port "cracks," as the enginemen say. File half the amount off each end of the valve, as it is absolutely essential to keep the exhaust cavity dead in the middle. Then try again; when the port cracks exactly on each dead-centre, the length of valve is correct.

Now turn the wheels backwards, and watch the valve again; if the ports crack on the dead-centres, the stop-collar is O.K. and the job is done on that cylinder. However, if the ports don't crack until the crank has passed dead-centre, the step or shoulder on the stop-collar is cut too far back, and a little piece of brass must be screwed or soldered to the contact edge, to bring it forward a little. To find enough, and a little bit must be chipped off at the place where the pin makes contact. This job can easily be done with a little chisel made from a bit of silver-steel. When the ports crack on each dead-centre, when turning the wheels in either direction, the valve setting is O.K. and the set-screw in the stop collar can be tightened up "for keeps." Give the other cylinder a dose of the same medicine; replace steam-chest cover, put in all the cylinder fixing screws, and put the nuts on the spigots at the motion-plate end of the gude bars. The valve spindle forks can also be pinned to the spindles, to prevent turning, if the pins should be taken out at any time. If a few drops of cylinder oil are put in the steam-chest, and a tyre pump connected to it by aid of an improvised adapter, the wheels should spin freely in either direction, if a few pounds of air are pumped into the steam-chest. If the pump is operated vigorously, it should be impossible to prevent the wheels turning, by anybody of average strength, by gripping the treads. If you grip the wheels of the 5-in. job, and get somebody to give the pump two or three sharp strokes, she will snatch them away from you easily. The beats should be sharp and clear, with the wheels turning in either direction.

Next stage, the gab motion.

An Improved Design of Hand-pump

By Andrew Todd



Side view of completed pump

A COMMON form of hand-pump used for boiler feeding in model boats and locomotives is that shown in Fig. 1. It has many faults; a number of model engineers have made successful ones, but I know a few who haven't, and it was the failure of one of my own that made me get out the following design.

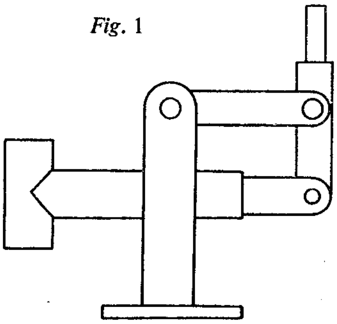
The following is a list of defects I have found with pumps made to Fig. 1.

(1) Excessive barrel wear; (2) worn rams; (3) no adjustment to packing; (4) excessive wear on links and pins; (5) pump barrel parted from baseplate.

Excessive barrel wear and worn rams are caused chiefly by amateur drivers allowing the weight of their arms and shoulders to press down on the pump lever. Soft brass tube, usually specified for the barrels, is not good enough to stand up to this treatment.

Fig. 2 shows a much better design of pump, where all the load of the arms is taken by the body of pump and not directly by the ram.

Fig. 1



Wear on ram and barrel means worn packing, and while not serious inside a locomotive tender, it does make a mess of a model boat when water leaks into it at every stroke of the pump.

I do not like packed rams. I have only come across one example used in big practice, and that was the plunger of a hydraulic jack-pump, which had a groove about an inch long packed with a leather strip.

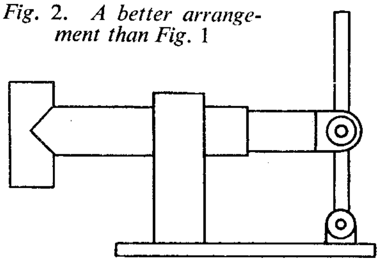
A packing gland is a much better arrangement, as it can be adjusted to take up wear. The screwed type of gland is, I think, preferable to the one with studs and nuts to pull up gland, but in the bigger sizes is much more difficult to make, unless one has a screw-cutting lathe. Taps and dies in sizes over $\frac{1}{2}$ in. diameter are expensive. One might say that if a packed piston is a satisfactory seal, why not a packed ram? The reason is that a piston is working in a true plane, being supported by a crosshead and guide bars, while the pump ram has no support.

Wear on links and pins is usually excessive. In some cases they positively rattle, and while it doesn't affect the working of the pump, it does not sound good. Most of the wear takes place on the pin between ram and lever, again by too much weight being put on the handle. A pump made to the design in Fig. 2 would cut out a lot of this wear.

Some years ago I was in charge of the tools and tackle used by a Midland's firm of engineers. I had a lot of trouble with hydraulic jacks; it was impossible to keep packed pump rams tight for long, and as I could not fit a packing gland to the pump, a new ram was made, in which it was possible to screw up the packing inside the ram by an external nut, and thus make packing tight without removing ram. Six of these rams were fitted and proved most satisfactory. The drawing, Fig. 3, shows a pump I have made for a locomotive, using the above feature.

This pump has been made for a 6-coupled version of *Juliet*, which I am building. While I would still prefer a gland of the screwed type, to the above, it was going to make the pump too wide to go into the space available. As it is practically impossible to adjust any kind of gland in the space available in a side tank, the pump was made as accessible as possible, and by removing two 2-B.A. nuts and one union, the pump can be lifted right out of the tank. The adjusting nut is then tightened up a little, and the pump replaced, all in a few minutes. Projecting from body of pump is a bracket which carries a trunnion block, to which the stainless-steel lever is anchored. A similar trunnion block is fitted to the end of ram, and the lever is free to slide in this trunnion. Thus all the weight in a downward direction is taken entirely on the bracket and none of

Fig. 2. *A better arrangement than Fig.* 1

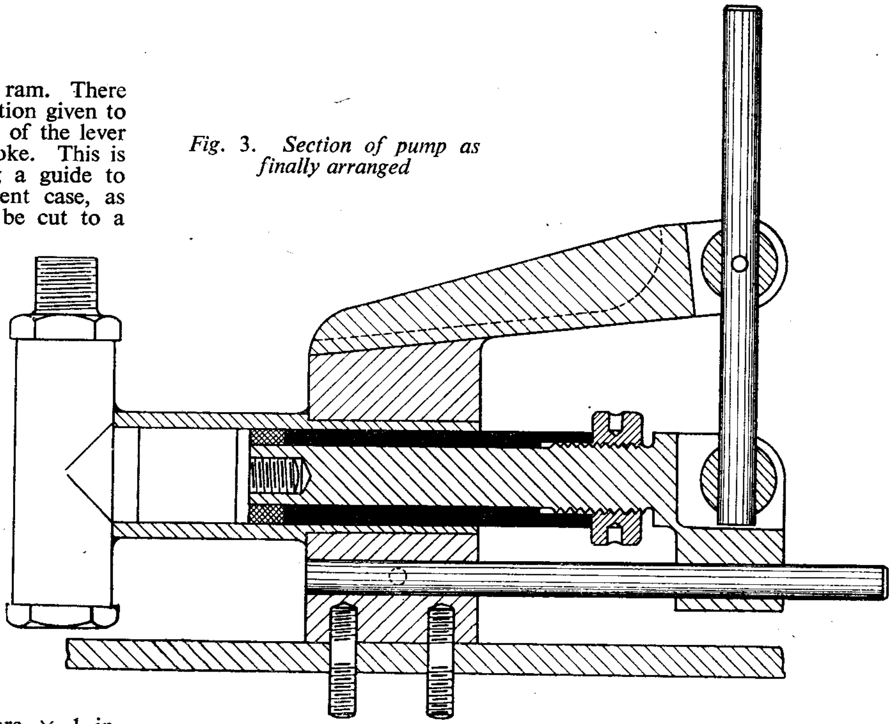


it is transmitted to the ram. There is an up and down motion given to ram, due to angularity of the lever at each end of the stroke. This is counteracted by fitting a guide to the ram. In the present case, as overall length had to be cut to a minimum, this decided the type of guide to be used, but I would prefer to extend the ram to act as a guide, as in Fig. 4.

I built up the body, using chunks of gunmetal, but a casting is to be preferred; the boring of the barrel was done after all the brazing had been carried out. The valve-box is as arranged by "L.B.S.C." and I have used this type of valve-box in pumps running up to 3,000 r.p.m. This pump is $\frac{1}{2}$ in. bore × 1 in. stroke, with a plunger adjusting nut screwed $\frac{3}{8}$ in. × 40 t.p.i., the trunnion blocks being $\frac{3}{8}$ diameter × $\frac{1}{2}$ in. long, with the lever of $\frac{3}{16}$ in. diameter stainless-steel rod. The top trunnion is drilled and tapped to take two stainless-steel grub-screws, which tighten into countersinks in the lever, thus locking it positively in the trunnion.

The pump is bolted through the soleplate of tank and footplate by two 2-B.A. bronze studs. These studs should be amply strong, as I know of one or two cases where the holding-down bolts have broken.

Fig. 3. Section of pump as finally arranged



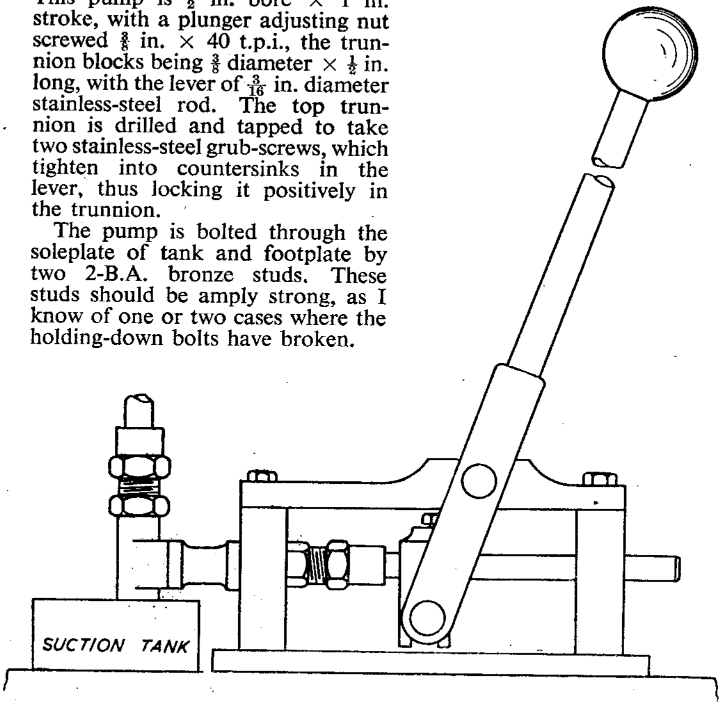
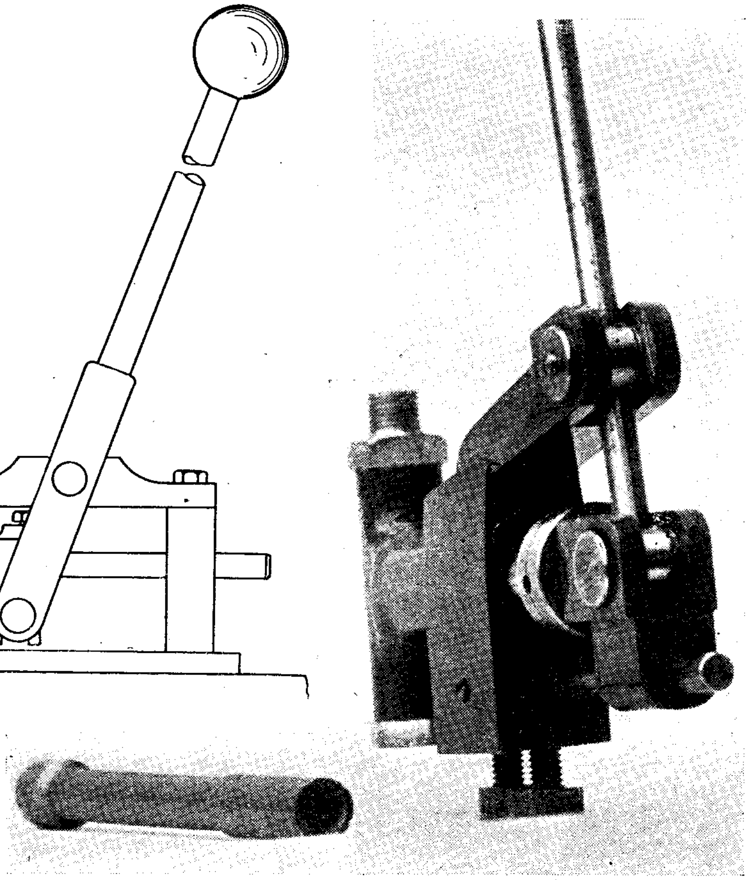


Fig. 4. A high pressure test pump with ram extended to form guide



Right: Photograph showing the guide and trunnions

READERS' LETTERS

● **Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.**

IMITATION BRICKWORK

DEAR SIR,—We take this opportunity of thanking Mr. L. H. Sparey for his complimentary remarks on our table engine in THE MODEL ENGINEER for September 10th. We are, however, rather surprised at his criticisms of the tiled floor and particularly the statement that this is scratched wood. The tiled floor is not wood at all, but is made from plastic, which, in our opinion, although not perfect, gives a much better effect than paint and scratched wood.

Regarding brickwork and tiling as such, we are very interested in Mr. Sparey's statement that this can be imitated, and more particularly as he has done it. We think it would be of great advantage to all model engineers if Mr. Sparey would write an article dealing with these two subjects. We are personally particularly interested in brickwork, and shall be glad to know if Mr. Sparey's plaster of paris bricks would stand up to transport and vibration, what would be the effect of oil on them, and how a model would be secured to such bricks.

The base for the engine we have modelled would actually be built of stone setts. Mr. Sparey's views on the imitation of this construction would be interesting, bearing in mind "L.B.S.Cs'." remarks that "nature cannot be scaled" and, therefore, the grain size of whatever material used for imitation would have to be reduced to whatever the scale of the model may be.

Yours faithfully,

Smethwick. A. J. KENT.
T. N. TAPPER.

ENGINE FOUNDATIONS

DEAR SIR,—How much improved the model of the Easton and Amos "grasshopper" engine, on the cover of THE MODEL ENGINEER for September 17th, 1953, would be, if its base had been made in the manner which a mason would have adopted.

These old engines, and other machines of any importance, were put upon a base of what the mill-wright, or the mason working for him, calls "ashlar" (Fig. 1). The "courses" of stone may not be of even thickness, but the joints are all worked perfectly true and flat, and if *A*, Fig. 1 is the bedplate of an engine, and *D* the level of the floor, the stone will appear as at *B* and *C*; if the courses vary in height, the larger blocks will be as at *C*, the lowest, and upon the topmost course *B* will be worked the mason's "chamfer" or bevel edge, as shown.

Before the days of concrete in its modern form, masons often had to prepare foundations out-of-doors for swing bridges, in harbour entrances, etc., and the civil engineers who directed these works often

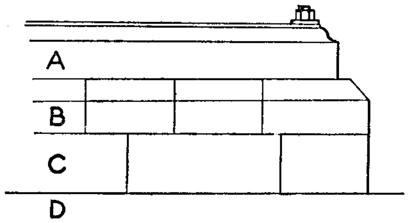


Fig. 1

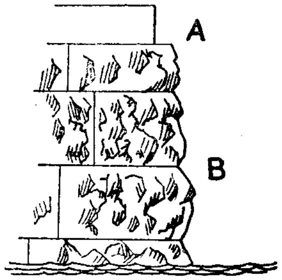


Fig. 2

saved expense, by requiring the masons only to work the jointed faces, and leave, rough from the quarry, the exposed faces and those at the back of the stone abutting upon the mass concrete filling. In those days the concrete had to be well protected by good hard stone, and the same applied to river works. In the sketch Fig. 2, if *A* is the base of some work, such "rock faced" blocks appear as at *B*; again, the biggest blocks lower down.

The maker of a mechanical model will have no means of working stone, but those firms who prepare slabs for the cemetery masons are always sawing and planing stone, and it may be that they would perhaps prepare some small slab for a model engine, or hydraulic press, etc., to stand upon. Such a stone as that called "Ham Hill" or "York" would be good; the masons use these as foundations for their fancy marble work. To avoid gross and awful errors, do not let any *white marble* be put into a base, or the job will look as if it came from the local cemetery! Certainly if the writer made a model of any old engineering object, the work would be stood upon a proper base of real stone, if it could be obtained, and such a base would make a wonderful improvement to the "grasshopper."

Yours faithfully,

London, N.W.7. H. H. NICHOLLS.

IGNITION PHENOMENA

DEAR SIR,—Mr. Curwen's observations on polarity effects on sparking-plugs are very interesting. In the case of my six-cylinder engine, however, the misfiring is indiscriminate. One of the first points to be checked was whether any one group of plugs was worse than another to see whether the defect was associated with the contact-breaker or the distributor, but no pattern of behaviour was observed, although Nos. 1 and 6 cylinders were slightly less susceptible than the others.

It would be of interest to know whether Mr. Curwen checked the voltage of his spark on positive and negative on the plugs themselves when running-in the engine. It is well known that a given gap will break down at a different voltage on positive and negative impulse. As a general rule the breakdown will occur at a voltage up to 30 per cent. lower when the insulated electrode is positive, e.g. see B.S.358. The plug conditions under pressure in an engine cylinder are comparatively complicated. For example, a clean plug could be made to misfire by adjusting the compression pressure in the cylinder, as, above a limiting pressure, the insulator surface sparks over at a lower voltage as the pressure is increased still further, while the breakdown voltage across the plug point will rise fairly steadily with pressure.

Clean oil on the plug can affect the passage of a spark in several ways. For example, if the plug points were immersed in oil, the ignition system may have insufficient voltage to puncture the oil gap; if a spark did pass under these conditions the ignition of the charge could be delayed or prevented altogether.

It is well known that the breakdown voltage of small gaps is very erratic, unless subjected to preliminary ionisation in some way. This is the case most particularly when the gap is approaching the limit for the applied voltage. In gaps of the type obtained in sparking-plugs, i.e. where one electrode is supported by a ceramic type insulator in close proximity to one electrode, the preliminary ionisation is frequently provided by an electron ejected from the insulator surface by the field produced when the voltage is applied to the plug. If the insulator happens to be coated with oil the emission of an electron may be modified, resulting in a variation in the behaviour of the gap. The easiest remedy is to use large voltages and small gaps; shot-blasting of plugs has been used commercially, also.

Carbonised oil on a plug would usually be effective in short-circuiting a plug gap either by providing a low resistance path over the plug surface or by bridging the points. It is in these circumstances that a gap in the plug lead can be of assistance in preventing a misfire, as the low resistance path is disconnected from the ignition device and allows the voltage to build up to a sufficient value before it is applied to the plug. The breakdown of the external gap increases the rate of rise of voltage across the plug points very appreciably. It can be demonstrated, by means of suitable apparatus, that a high voltage can be made to appear across a low resistance if the rate of rise of the voltage is sufficiently fast, e.g. a spark can be made to jump between the points of two electrodes immersed in water.

I am afraid I have done very little towards explaining Mr. Curwen's effects, but perhaps these remarks may stimulate some fresh ideas and serve to demonstrate the extremely complex nature of the apparently simple phenomena which stop our engines from working.

The subject of sparks has been interesting scientists for many years. The files of literature and text-books available would take a year or two to read, but in a recent article one of the leading exponents of the subject makes it obvious that the mechanism of the spark discharge is still not completely understood.

Surely the simplest solution is to prevent the oil getting on the plugs; always provided it *is* oil, and not bad mixture or distribution, which is the root of the trouble.

The term "oiling up" is used very loosely by most of us, myself included, to describe a plug which is wet either with petrol or lubricating oil or both. Although the effect is the same, the source of the trouble may be quite different.

Yours faithfully,

Stretford. F. W. WATERTON.

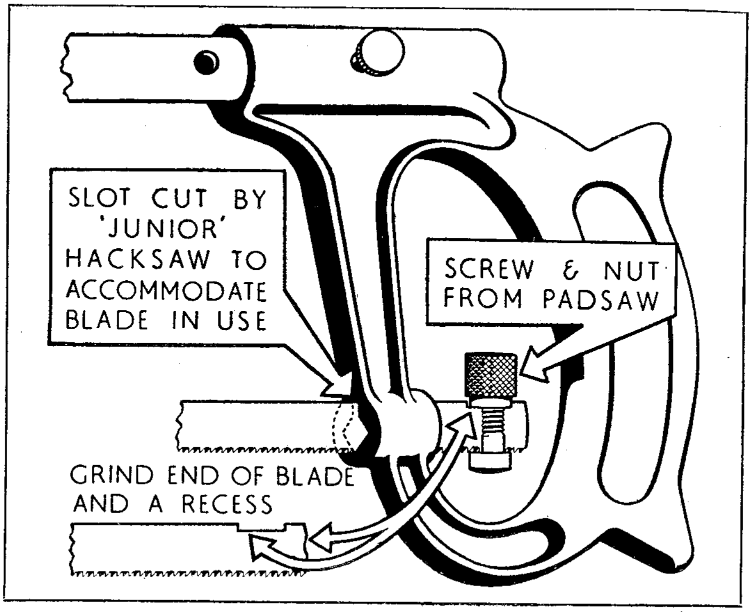
USING BROKEN HACKSAW BLADES

ON a recent occasion, when sawing a piece of material so tough that only a high speed blade would cut it satisfactorily, the job was brought to a sudden stop by breakage of the blade when the cut was only about half-way through. Needless to say, the shops were closed and no other blade was available, so a means had to be found of using the ten inches of blade still intact. The solution arrived at is believed to be original, and may help other readers to extend the life of blades which break near the end.

It utilises the clamp-bolt of the "Eclipse" pad-saw, which is designed to use short ends of blades, when working in confined spaces. This bolt is split longitudinally and provided with a knurled tubular nut which secures the blade in the frame. This provides a ready-made accessory for the conversion of the hacksaw frame, which in the case illustrated is an "Eclipse" tubular type, having a die-cast handle.

The pin on the blade-holder at the handle end is first shortened to enable it to be withdrawn through the square hole in the handle. A slot is then cut with the "Junior" hacksaw at the top point of the square hole, deep enough to allow a standard hacksaw blade to pass through. The broken hacksaw blade has a recess ground in its top edge, about $\frac{1}{16}$ in. deep, and wide enough to enable the nut of the pad-saw clamp-bolt to sink into it. When the nut is screwed down hand-tight, it is thus prevented sliding off the blade, and it will hold fast when tension is applied to the other end of the blade in the usual way.

Should the blade be broken at the other end, the square hole at the outer end of the frame can be slotted out as before and the holder, with wing-nut, transferred to the handle end. It may be found necessary to drill one or more additional cross holes in the tube of the frame to enable it to be adjusted to take the shortened blades.—R. E. PRIESTLEY.



QUERIES AND REPLIES

"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:

(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

Twin-cylinder Petrol Engine

I am constructing a twin-cylinder o.h.v. water-cooled petrol engine, with cylinders 1½ in. bore × 1½ in. stroke, and would be very grateful if you would give me the answers to the following queries:—

(1) *Will 5/32 in. lift on cams be sufficient?*

(2) *The depth of combustion chambers?*

(3) *Will flat-topped pistons be suitable?*

(4) *The minimum diameter of inlet and exhausts ports?*

(5) *Does the angle at which the cranks are set govern to any extent the power output?*

C.W. (Wath-on-Dearne).

We presume that this is a 4-stroke engine in view of your reference to cams.

(1) With an engine of this size, intended for moderate performance, the valves should be from ½ in. to ⅝ in. diameter, in which case the 5/32 in. lift should be fairly normal.

(2) The depth of combustion chamber will depend on the compression ratio, and this in turn will depend on the type of performance for which the engine is intended. For a moderate performance, a compression ratio of about 6 : 1 will give satisfactory results, and in this case the clearance in the combustion chamber should be approximately 5/16 in. If any experimenting is done, it is best to start with a relatively low compression pressure and raise it afterwards, rather than working the other way.

(3) The shape of pistons will depend on the arrangement of valves, but assuming that the valves were vertical in the head, a flat-topped piston would be correct.

(4) This question has already been dealt with under the heading (1).

(5) The relative angles of the cranks do not have any appreciable effect on the power output, but they affect the evenness of the torque and also the balance of the engine. In the case of a twin-cylinder 4-stroke engine with the cylinders in line on one crankshaft, the usual practice in modern engines is to put the two pistons in the same plane, so that they both go up and down together, but the cylinders fire on alternate strokes. This gives a fairly even torque, but the static balance is no better than an ordinary single-cylinder engine. The alternative arrangement of putting the cranks at 180° was very considerably used in the early engines, but experience has shown that even turning movement is more important than static balance.

Cutting Compound

Some time ago I obtained a small quantity of screw-cutting compound which I believe was based on lard oil and graphite, which I find far superior to anything I have used before. Can you please tell me of any firm who can supply this lard oil in small quantities?

A. J. (Ramsgate).

We do not know of anyone who supplies a ready-made compound of this nature. Lard oil has been rather difficult to obtain for some years, and substitutes, consisting of compounded mineral oils, have been supplied by several manufacturers. We have recently been informed, however, that lard oil is again on the market, and this and other cutting compounds can be obtained from Messrs. Edgar Vaughan & Co. Ltd., Legge Street, Birmingham.

Worm Dividing Gears

I have two sets of worm reduction gears, one having a ratio of 25 : 1 and the other 36 : 1. I wish to make a dividing head, and would be glad if you would let me know which of the two is best to use for this purpose. To begin with I intend to manage with just one index plate.

W.L. (London, S.W.5).

Neither of the ratios you suggest is really well suited to this purpose, as the small number of factors provided by the worm wheel would necessitate a larger number of division plates than is desirable.

The most satisfactory ratio of worm reduction for a dividing head is 60 : 1, as this contains the largest number of factors, in relation to number of teeth, and reduces the need for a large array of numbers of holes in division plates.

Motor for Grinding Wheels

An article in THE MODEL ENGINEER *some time ago described a 5-in. grinder driven by a 1/16 h.p. motor. As all the commercial 5-in. grinders I have seen are fitted with motors of at least 1/3 h.p. I am interested to know how this could be driven by a motor of such a small power. Is there some mechanical advantage to be gained by mounting the grinding wheels on a separate shaft driven from the motor by a belt? Does this provide a flywheel effect, or does the very high speed of the motor give the same effect as using low gear in a motor-car to climb a hill? What is the maximum percentage of power that can be transmitted from a motor by a belt drive?*

J.A.S. (Ealing, W.5.).

The nominal rating of the power of motors does not necessarly bear any true relation to their actual power. It often happens that a motor which is rated as 1/16 h.p. may in actual fact be capable of developing a good deal more, though possibly at the risk of overheating or overloading the windings.

The tendency among motor manufacturers at the present time is to use one size of frame for a number of different power ratings, and the formula for power output is often extremely liberal. Another point which arises from using motors for this particular purpose is that in some cases they are only used for light or intermittent work. This applies generally to grinders used in a small workshop for grinding lathe tools, in which the actual grinding operation is not heavy and may not last more than a few seconds at a time. In such a case, a much lower power motor could be used than in the case of a grinder on continuously heavy work.

When once the grinding wheel has attained its normal working speed, its momentum is quite capable of keeping it in motion with relatively slow deceleration, while under load.

In a belt-driven machine, some loss in friction is always produced by the belt, but it is impossible to state exactly how much this would be, because a good deal will depend on belt tension and also on the type of bearings employed. The estimate of about 10 per cent. loss would hold good in the majority of cases.

Portsmouth Model Clubs Exhibition

ALL the modelling clubs in Portsmouth combined to hold a highly successful six-day exhibition in Highland Road School, Southsea, a few weeks ago. The value of the models shown was nearly £10,000.

There was a large and varied display of models in five main sections contributed, respectively, by the Portsmouth Model Engineering Society, the Portsmouth Model Yacht Club, the Model Power Boat Club, the Model Aircraft Club and the Model Car Club. By far the greater part of the models in all sections were the work of members living in the immediate neighbourhood of Portsmouth.

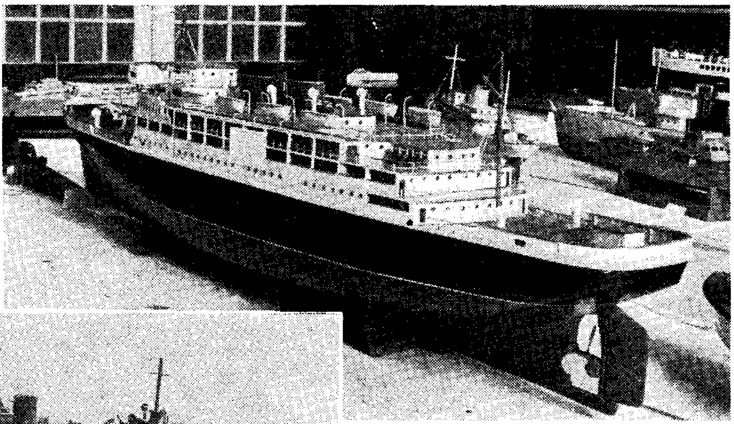
Throughout the exhibition special displays were organised.

Visitors were able to enjoy daily joy-rides on one or more model railways laid out in the playground and daily views of races on the Model Car Club's miniature racing track.

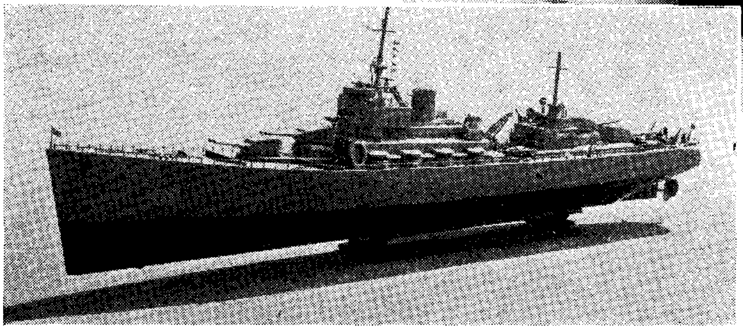
Indoors, visitors were able to see demonstrations of Mr. Downing's radio-controlled model of a light cruiser; of Mr. Tysoe's centrally controlled model of a railway system, of the working scale model of the old Cornish pumping engine, "Old Bess," and of many other interesting models.

The combined committee of the Portsmouth model clubs must be congratulated on a superb exhibition which has done much to popularise the model-maker's craft in the Portsmouth area.

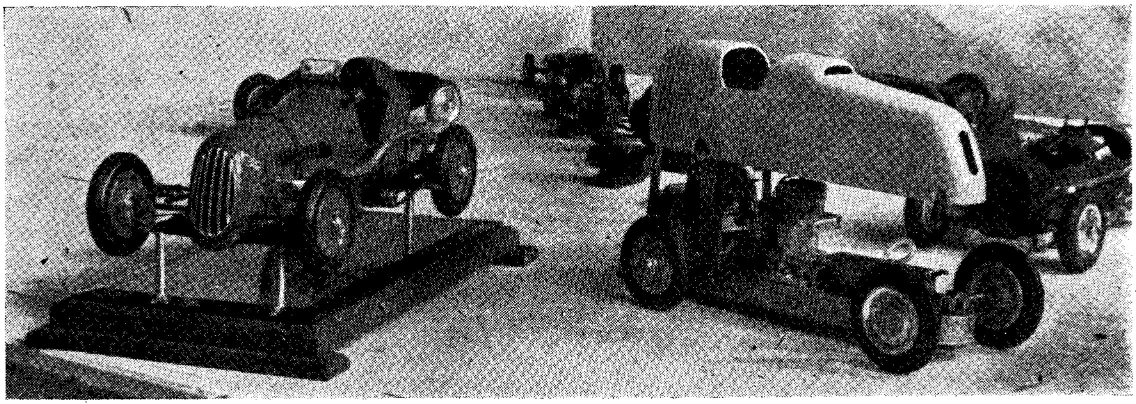
The chairman of the committee was Mr. Downing of the Model Power Boat Club, and the secretary was Mr. G. S. Stevenson of the Model Aircraft Club.



"Sandra Maria," Mr. Bishop's electrically-powered model of an ocean-going liner was one of the outstanding exhibits in the Power Boat section



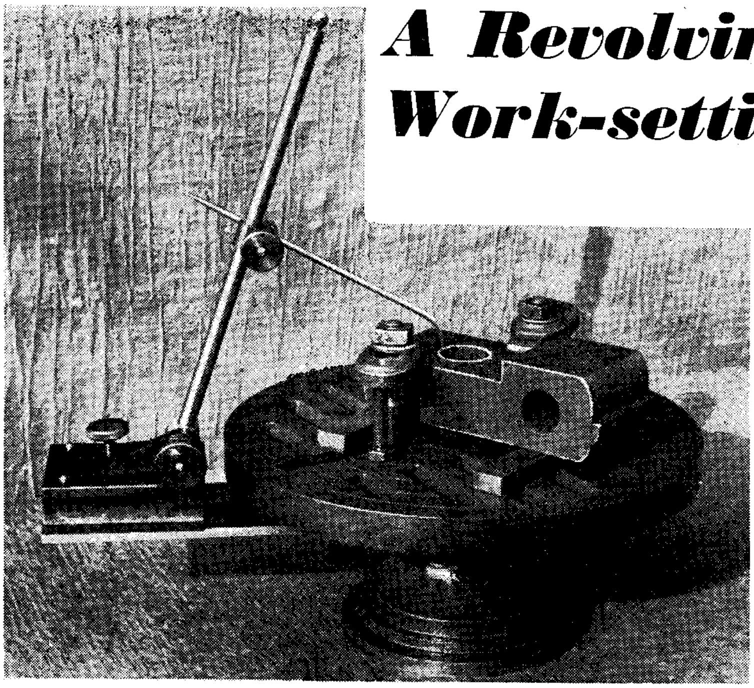
Left: Mr. Downing's radio-controlled model of an 8-gun Light Cruiser which attracted universal attention. The hull structure is of welded dural



Two methods of displaying the works. On the left is Messrs. C. H. S. and W. F. Chandler's 1938 *Austin* 747 *OHC racer mounted on a mirror; on the right Mr. P. Bailey's model car with the body raised clear of the engine and chassis*

A Revolving Work-setting Fixture

By J. D. Elam



Work packed up and cored hole being centralised

THE device shown in the photographs will be found very helpful in setting up work on the faceplate, and will save much time, temper and language. Its construction will be fairly clear from the photographs, no measurements are given, as it can be made to suit any size of lathe. In my case, the latter is an early Drummond type with $\frac{3}{4}$-in. nose and No. 1 Morse taper socket.

The faceplate shown in the photographs is $9\frac{1}{2}$ in. diameter. The base was made from a pattern which was originally part of a show stand to which a short arm was added to take the extension. Suitable ball-bearings were obtained from garage scrap, and the housing was then machined to take the bearings a push fit. The same applies to the fit of the spindle in the bearings. A felt washer is fitted to exclude dirt from the bearing, and this is protected by a thin metal washer over the top bearing held in position by a circular wire clip, a groove for which is turned in the housing.

As an elaboration, I drilled the spindle through and opened it out to take a No. 1 Morse pump centre which is seen lying opposite the spindle. It will be noted that a blind hole is drilled in the collar of spindle, this is to take a tommy-bar which engages with the peg seen on top of the base to facilitate the screwing on and off of the faceplate. In order to set up a casting or other piece of work for machining or boring, the faceplate is screwed on the spindle nose, and with the scribing block resting on the extension arm, it is possible to set work up by sliding it about as required until the marking-out line follows the scriber's point. It is clamped down, and after removing the scribing block, the work may be balanced by holding the extension arm vertically in the jaws of a vice, and adding weights as required, until there is no tendency for it to stop in one place. The faceplate may then be transferred to the mandrel nose for machining, the whole operation taking only a fraction of the time usually occupied in setting up with the faceplate mounted on the lathe mandrel.

Right: The fixture used as a balancer

Below: The component parts